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LEGISLATIVE HEARING TO ADDRESS SPECTRUM AND PUBLIC SAFETY ISSUES

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY

OF THE

COMMITTEE ON ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

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LEGISLATIVE HEARING TO ADDRESS SPECTRUM AND PUBLIC SAFETY ISSUES

FRIDAY, JULY 15, 2011

House of Representatives,
Subcommittee on Communications and Technology,
Committee on Energy and Commerce,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:17 a.m., in room 2123, Rayburn House Office Building, Hon. Greg Walden (chairman of the subcommittee) presiding.

Members present: Representatives Walden, Terry, Stearns, Shimkus, Blackburn, Bilbray, Bass, Latta, Guthrie, Eshoo, Matsui, Barrow, Dingell (ex officio), and Waxman (ex officio).

Staff present: Jim Barnette, General Counsel; Ray Baum, Senior Policy Advisor/Director of Coalitions; Michael Beckerman, Deputy Staff Director; Neil Fried, Chief Counsel, Communications and Technology; Kirby Howard, Legislative Clerk; Debbee Keller, Press Secretary; Carly McWilliams, Legislative Clerk; David Redl, Counsel, Communications and Technology; Lyn Walker, Coordinator, Admin/Human Resources; Nicholas Degani, FCC Detailee; Kelsey Guyselman, Legal Intern; Roger Sherman, Minority Chief Counsel; Shawn Chang, Minority Counsel; Jeff Cohen, Minority Counsel; Sarah Fisher, Minority Policy Analyst; Phil Barnett, Minority Staff Director; and Pat Delgado, Chief of Staff for Mr. Waxman.

Mr. Walden. We are going to go ahead and get started so that we can get our statements and the witnesses' statements. Today is a little challenging because we do have a series of votes on the floor, they estimate in about an hour and 15. So we will try to get through as much of this as we can.

OPENING STATEMENT OF HON. GREG WALDEN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OREGON

Good morning. I welcome our witnesses. I appreciate your counsel, along with that of dozens of others whom I think we have all met with and I have met with, from whom we have received testimony at our four prior hearings on spectrum policy and the individual meetings that we have had and the information that has come in. It has all been helpful.

I am a firm believer that open and fair public processes can lead to better public policy outcomes, and the competing discussion drafts are a welcome addition to this process. Despite the differences on paper, the reality is we are not as far apart as it might seem, and we are personally committed to doing all within our power to write a bipartisan bill in the end.

I believe we share common goals on this subcommittee when it comes to spectrum policy. We want to finally answer the call of our public safety officials and ensure that they have the best, most innovative and affordable technology operating on a bulletproof network in an inoperable basis in times of need. And we will do our part as a Federal partner to make sure that that happens. We want to ensure that the scarce and valuable spectrum that the public owns is put to its best and highest use, with any proceeds enuring to the benefit of the public. And we want to ensure that those who voluntarily help us achieve this goal are treated respectfully and appropriately for their assistance.

We all want to spur new American innovation and create high-paying jobs, especially in our own districts. We can enact the biggest jobs bill in the Congress that actually creates private-sector jobs throughout the land and results in deficit reduction at the same time. This is within the power of this committee to do. Chairman Upton has given us wide latitude as a subcommittee to achieve these goals. And throughout this process, he has encouraged us at every turn to find a bipartisan solution, and I thank him for his calm, and thoughtful and patient leadership.

And let us be honest, but for the President's call in February to allocate the D-block, we would be much further along today. After all, about a year ago, then-Chairman Waxman eloquently and forcefully argued that his discussion draft that auctioned the D-block was the right public policy. The National Broadband Plan calls for auctioning the D-block, and the principles endorsed by the 9/11 Commission Chair and Vice Chair last year, former Commission Chair—or former Commission member Senator Slade Gorton this year, and is still supported by the current FCC Chairman. It is also current law. And any plan to allocate this prime spectrum opens a $3 billion hole in the Nation's budget.

I know there are arguments about how that was then, and this is now, and things have changed, but the heart of the matter, absent the President's proposal, D-block would not be quite the stumbling block it has become.

Now, my comments are not intended to be partisan; however, they are intended to just state the political reality that has befallen our committee. I am just stating the obvious about the awkward. Our staffs on both sides of the aisle have joined us in healthy and vigorous discussions about other policy issues. Our product is strengthened by these discussions. When it became clear we could not reach agreement in time for this hearing, both sides chose to release their drafts in current form to facilitate further discussion and to solicit your input. Republicans have included the Inslee-Upton-Boucher government relocation bill from the last Congress in that same spirit. Our discussion draft reflects input from the minority, and that input is very much appreciated.

The Republican draft relies on the local expertise at the State level for implementation of the public safety network while providing for a strong Federal role in assuring interoperability. To capitalize on the United States' leading position in wireless broadband technology and services, it also relies heavily on the commercial sector's expertise through public-private partnerships.

We still have unresolved issues regarding the unlicensed space, interoperability requirements beyond those of public safety, and conditions on licenses, to name just a few. We will continue to work on these issues. Meanwhile, I welcome the input and counsel of my colleagues, our witnesses and others who can help us get this policy right for the public. But we all know the clock is ticking, and we must close out this matter sooner rather than later.

With that, I would yield the balance of my time to the vice chair of the committee.

[The prepared statement of Mr. Walden follows:]

Statement of the Honorable Greg Walden
Chairman, Subcommittee on Communications and Technology
Legislative Hearing to Address Spectrum and Public Safety Issues
July 15, 2011

Good morning. I welcome our witnesses and appreciate their counsel, along with that from dozens of others with whom I've met, and from whom we've received testimony at our four prior hearings on spectrum policy.

I am a firm believer that an open and fair public processes can lead to better public policy outcomes. The competing discussion drafts are a welcome addition to this process. Despite the differences on paper, the reality is we are not as far apart as it might seem and we are personally committed to doing all within our power to write a bipartisan bill in the end.

I believe we share common goals on this subcommittee when it comes to spectrum policy: We want to finally answer the call of our public safety officials and ensure they have the best, most innovative and affordable technology operating on a bullet-proof network in an interoperable basis in times of need. And we will do our part as a federal partner to make that happen.

We want to ensure that the scarce and valuable spectrum the public owns is put to its best and highest use, with any financial proceeds ensuring to the benefit of the public. And we want to ensure that those who voluntarily help us achieve this goal are treated respectfully and appropriately for their assistance.

We all want to spur new American innovation and create high-paying jobs (especially in our own districts). We can enact the biggest jobs bill in the Congress that actually creates private sector jobs throughout the land and results in deficit reduction at the same time. This is within our power to do.

Chairman Upton has given us wide latitude as a subcommittee to achieve these goals. And throughout this process he has encouraged us at every turn to find a bipartisan solution. And I thank him for his calm and thoughtful and patient leadership.

And let's be honest, but for the President's call in February to allocate the D block, we'd be much further along today. After all, about a year ago then Chairman Waxman eloquently and forcefully argued that his discussion draft that auctioned the D block was the right public policy. The National Broadband Plan calls for auctioning the D block, and that principle was endorsed by the 9-11 Commission chair and vice chair last year, former commission member Sen. Slade Gorton this year, and is still supported by the FCC Chairman. It is also current law, and any plan to allocate this prime spectrum opens a $3 billion hole in the deficit.

I know we'll hear arguments about how "that was then and this is now and things have changed," but at the heart of the matter, absent the President's proposal, D block would not be quite the stumbling block it has become. My comments are not intended to be partisan, however, they are intended to state the political reality that has fallen upon our committee. I'm just stating the obvious about the awkward.

Our staffs on both sides of the aisle have joined us in healthy and vigorous discussions about other policy issues. Our product is strengthened by these discussions. When it became clear we would not reach agreement in time for this hearing, both sides chose to release their drafts in current form to facilitate further discussion.

Republicans included the Inslee-Upton-Boucher government relocation bill from last Congress in the same spirit. Our discussion draft reflects input from the minority, and is very much the better for it.

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We still have unresolved issues regarding the unlicensed space, interoperability requirements beyond those of public safety, and conditions on licenses, to name a few. We will continue to work on these. Meanwhile, I welcome the input and counsel of my colleagues, our witness and others who can help us get this policy done properly.

But we all know that the clock is ticking and we must close out this matter sooner rather than later.

OPENING STATEMENT OF HON. LEE TERRY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEBRASKA

Mr. TERRY. Thank you. And I just want to commend you for the methodical and mature way of processing through very complicated and sometimes divisive issues. This is something we have to get done.

We have to have a comprehensive spectrum bill. There is no doubt everyone agrees with that. The dividing points have been public safety, D-block, and I think you took a path that addressed both of the issues. They need help, public safety, "they." You have tried to resolve the issues of the broadcasters, and I think you have taken a very good approach on there, resolving those issues.

So I encourage you to work with our Democratic side. I would like to see a bipartisan bill here. I do agree with you, I think we are close.

I also want to just say last that I feel that the debt talks do have an impact here in the sense that this is one way of auctioning spectrum that can actually be a revenue raiser for the Federal Government to offset our deficit, and I think we have a responsibility to follow through.

I yield back.

Mr. WALDEN. I thank the gentleman for his comments.

I turn now to the ranking member of the subcommittee, my friend, Ms. Eshoo from California.

OPENING STATEMENT OF HON. ANNA G. ESHOO, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Ms. ESHOO. Thank you, Mr. Chairman, for not only having today's hearing, my thanks to all of the witnesses, especially those who had to travel long distances and endure interruptions in that travel, and to our respective staffs who have really worked very, very hard. But the work goes on. We are not done yet.

Three months ago this subcommittee began a major undertaking; the goal: Bring forward legislation to address our growing need for spectrum while providing our first responders with a nationwide interoperable broadband network. While the majority's discussion draft has provisions that I don't support, I remain optimistic. And I want to say that again: I remain optimistic that we can produce a bipartisan bill. We feel very strongly about that on our side as well.

To help with this effort, I joined with the full committee's ranking member, Mr. Waxman, to offer our preferred path in a discussion draft entitled the Public Safety Broadband and Wireless Innovation Act of 2011. The draft reflects the testimony heard during the subcommittee's four spectrum hearings, as well as the feedback of our fellow colleagues.

From the beginning of this effort, I have expressed my belief that a nationwide public safety network must have a strong governance structure, leverage the commercial sector, and be built in a cost-efficient manner. Our discussion draft reallocates the D-block to public safety and includes a carefully developed, effective and efficient national governance mechanism with sufficient oversight and accountability.

In the area of voluntary incentive auctions, we shouldn't be overly prescriptive, I don't believe anyway, in our approach. We need to ensure that a process is fair to broadcasters and provides the FCC flexibility to carry out an auction and the subsequent repacking of the TV band. This discussion draft accomplishes, I believe, these goals.

To date, unlicensed spectrum has unlocked tremendous innovation. I see it in my congressional district every day. By one estimate, within the next 5 years, WiFi devices will use more bandwidth than wire devices. That is really extraordinary. And I love saying that because I really do think it is the American way. I mean, this is where we enjoy more than an edge. Our discussion draft recognizes the importance of this resource not just for established technology companies, but for the entrepreneurs that exist now and will in the future.

We also need to look at ways to spur innovation in the public safety device market and afford more opportunities for public safety to partner with a variety of commercial service providers, including small carriers. Our discussion draft supports the development and testing of new interoperable, nonproprietary broadband technologies that will help drive down the cost of public safety devices and applications, and that is very, very important.

Our draft also calls for an examination into the feasibility of providing interoperability across the 700 megahertz band. In addition to supporting public safety, the 700 megahertz band interoperability would benefit the broader wireless ecosystem. It also will give consumers an expanded set of choices for commercially available devices like smart phones and tablets.

Finally, we can't forget about our Nation's 911 call centers. Someone said—referred to me recently as "the 911 queen." Well, I don't know about that, but I had been on it for a long time before it was—it became popular. There was very little interest on either side of the aisle in the issue, but, of course, the attack on our country really raised the issue up and put a spotlight on it.

As a founder and current cochair of the NextGen 911 Caucus with Mr. Shimkus in the House, I have fought to modernize our 911 call centers. It makes sense as we build a nationwide public safety network that we develop a plan to update our public safety answering points and emergency operation centers to support a Next Generation 911 system. Such a system will enable first responders to receive photos, videos and text messages that can improve the quality and speed of emergency response. Our draft lays the foundation for such a transition, providing the resources to examine the costs, the specifications and the legal framework. So I think we owe it to our Nation's first responders, to our innovators and the American people to come together and complete a bill.

I want to thank each one of our witnesses again, and I look forward to working with the chairman, with our respective staffs, with members on both sides of the aisle of this important subcommittee to move forward with bipartisan legislation.

And, Mr. Chairman, I have a request to enter into the record from the Bipartisan Policy Center a letter that was sent to Senators Rockefeller and Kay Bailey Hutchison from Tom Kean and Lee Hamilton, who were the Commission Chairman and Vice

Chairman of the 9/11 Commission. So with your permission, we can enter that into the record.

Thank you and I yield back.

Mr. WALDEN. Without objection.

[The information follows:]

BIPARTISAN POLICY CENTER

June 7, 2011

The Honorable Jay Rockefeller
Chairman
U.S. Senate Committee on Commerce,
Science, and Transportation
253 Russell Senate Office Bldg.
Washington, DC 20510

The Honorable Kay Bailey Hutchison
Ranking Member
U.S. Senate Committee on Commerce,
Science, and Transportation
253 Russell Senate Office Bldg.
Washington, DC 20510

Dear Chairman Rockefeller and Ranking Member Hutchison:

The inability of first responders to communicate with each other was a critical failure on September 11, 2001. Incompatible and inadequate communications led to needless loss of life. To remedy this failure, the 9/11 Commission recommended legislation to provide for the expedited and increased assignment of radio spectrum for public safety purposes.

We commend the Senate Commerce Committee for marking up the SPECTRUM Act (S. 911), which will allocate an additional 10 MHz of radio spectrum—the "D block"—to public safety. Using this spectrum, public safety agencies will be able to build a nationwide interoperable broadband network, allowing diverse agencies to communicate with each other, and supporting mission critical voice, video, text, and other data transmissions.

This legislation takes an important step forward in improving interoperability for first responders. We note, however, that first responders utilizing the D block public safety network may not be able to communicate on other networks should the D block go down in an emergency. Therefore, we urge the committee to examine how this type of interoperability can be achieved through this or other legislation.

We support the expeditious allocation of the D block spectrum to public safety. Congress must not approach this urgent matter at a leisurely pace, because quite literally lives are at stake.

Thank you for your vital efforts in this area.

Sincerely,

Tom Kean
9/11 Commission Chairman
Co-Chair, National Security
Preparedness Group

Lee Hamilton
9/11 Commission Vice Chairman
Co-Chair, National Security
Preparedness Group

1225 Eye Street NW, Suite 1000 Washington, DC 20005 (202) 204-2400 WWW.BIPARTISANPOLICY.ORG

Mr. WALDEN. I thank you. The gentlewoman's time has expired.

I would now recognize the gentleman from Illinois Mr. Shimkus if he has any comments.

OPENING STATEMENT OF HON. JOHN SHIMKUS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. SHIMKUS. I will take time, Mr. Chairman, and then I will yield some to Cliff, if that is all right.

Spectrum is so much more than D-block, and I do appreciate your comments about it is obvious about—stating the obvious about the awkward. And so all I would like to add is—a couple of things—is I do hope that the NextGen 911 Enhancement Act will be a part of this as we move forward; the NextGen Public Safety Technology Act, which Anna and I have been working on.

This political process is always kind of fun. You can claw and scratch on one day, and then you can give the good big hug on the next day as you work together on things that are important. I have been clawing and scratching a lot lately. But I appreciate the times when I can cross the aisle and give someone a hug. Anna is working real hard with me on this, and it makes up for some of my frailties, I guess.

The other thing is I am for private auction of the D-block regionally done. My concern is that if we don't do it in that way, we won't have deployment. Some of the worst cases of 911 lapses is where we don't have connectivity, where we don't have cellular connections, where we can't do identification location. And the stories that we heard when we started moving the stuff out about the people caught in the snowstorm in the mountains, calling and couldn't be found. The young kids in the rowboat in New York—Island Sound, that is—I am not going to diminish the importance of that.

And if we truly want a bipartisan process to go forward, we can't have this fight between urban and rural. We just can't do it. And the rural areas have to be brought along, and the only way I see that that is done is if we have really a competitive atmosphere, and that we—with strong requirements so that all the Americans can benefit from a new system.

With that, I will yield my time to Mr. Stearns.

OPENING STATEMENT OF HON. CLIFF STEARNS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. STEARNS. I thank my colleague.

Mr. Chairman, you and the staff, I want to compliment you on several provisions I particularly support in this draft legislation. First, I am pleased to see that the incentive auctions will be truly voluntary.

Second, it is important that broadcasters can maintain their service areas and are not forced into VHF.

Secondly, I am in strong support of preventing the FCC's ability to impose conditions on the auctions. Unencumbered auctions decrease in value and limit their full revenue potential. We simply cannot afford the expensive social policy the FCC will likely try to impose on these auctions if it is just simply given the authority.

And finally, as the clock continues to tick on the debt ceiling, and we just got back from a conference on this, and the government searches for ways to pull itself out of debt, we have a bill in front of us that can raise billions of dollars for this country. Therefore I hope, Mr. Chairman, we can move this quickly.

And I yield back.

Mr. SHIMKUS. I yield back my time, Mr. Chairman.

Mr. WALDEN. Does the gentleman from Ohio want to make any comments, Mr. Latta, in the remaining time before I go to Mr. Waxman?

Mr. LATTA. Well, thank you very much. I appreciate the gentleman for yielding.

All I can say is I appreciate the hearing today, Mr. Chairman, and also how important it is, especially on the question of spectrum as to where we can go, especially the voluntary auction side. I think it is important that we can also bring dollars into the Treasury and help this deficit. So I appreciate the hearing today. Thank you.

Mr. WALDEN. Thank you.

And now I will turn to Mr. Waxman for 5 minutes.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you, Mr. Chairman, for convening this hearing this morning to discuss how we can quickly provide public safety with a nationwide interoperable broadband network and make more spectrum available for wireless broadband. Both goals are critical to our country and require Congress to act quickly and decisively.

In less than 60 days, we will observe the 10th anniversary of the terrorist attacks on New York and Washington and the skies of Pennsylvania. Construction of a nationwide public safety broadband network remains critical unfinished business, and we should do everything possible to send a bill to the President that accomplishes this bipartisan objective.

After several constructive hearings on spectrum policy, today we will consider a Republican discussion draft. I am pleased that we will discuss specific details about incentive auctions, public safety governance and Federal spectrum relocation, and still hope we can find common ground on several other issues.

In order to highlight our areas of agreement and disagreement, yesterday Representative Eshoo and I released a discussion draft of the Public Safety Broadband and Wireless Innovation Act of 2011. Although many details of the bill we put forward differ from the Republican draft, Democrats on the committee hope we can develop one legislative vehicle that takes the best ideas from both proposals.

Senators Rockefeller and Hutchison did a commendable job on a bipartisan package to empower the FCC to conduct incentive auctions for broadcast spectrum and create a nationwide broadband network for public safety. The Democratic draft builds upon the bipartisan work of the Senate Commerce Committee.

With regard to public safety, committee Democrats believe we must establish a strong governance structure to manage the highly complex undertaking of building and managing an advanced wireless network. Through a nonprofit corporation streamlined to act quickly and efficiently, we have put in place a number of policies and requirements designed to ensure we reach our primary goal of nationwide interoperability for first responders. This corporation could be statutorily required to operate in a fiscally responsible manner and to provide the technical and management expertise this network will need. Public safety will have a strong voice, but the network will rely heavily on commercial know-how, national standards and existing infrastructure.

The public safety community has indicated its strong support for the robust governance approach in the Senate bill and in the Democratic draft. It is on the basis of this strong governance model and public safety's commitment to this approach that I have come to support reallocation of the D-block for public safety's use. Reallocation is the best way to ensure that public safety has the leverage to incentivize the public-private partnerships and network-sharing arrangements that are essential through constructing a nationwide broadband network. Moreover, reallocation allows us to plan for public safety's transition to broadband, and the Democratic draft requires the FCC to evaluate opportunities to gain additional efficiencies across all public safety spectrum, including the possible return of spectrum for future auction.

Finally, reallocation is the best chance we have to pass legislation into law. It has bipartisan support in the House and the Senate. The administration is strongly supportive, and the entire public safety community, including mayors, Governors and numerous other State and local officials, are united on this path forward. In my view, strong governance, oversight, accountability and smart spectrum management provide us with a good solution.

Although we have disagreements about the D-block, the specifics of a governance model and funding, Democrats and Republicans are not far apart on other details. We all agree that we need to leverage commercial networks, ensure that the public safety equipment market becomes more competitive, and allow State and local officials to play a significant role in the development of this network.

We also found a good amount of common ground on spectrum policy. Both Democrats and Republicans want to enable the FCC to conduct voluntary incentive auctions that are fair to broadcasters. We want the FCC to have sufficient flexibility to make auctions successful, although we have slightly different approaches to providing that flexibility. We don't agree on the future of—we don't agree on the future of unlicensed spectrum or on limiting the FCC's ability to impose conditions on spectrum licenses in the future. These decisions must be made by the expert agency based on market conditions and other factors.

I would like to thank our witnesses for being here. I look forward to your testimony. And thank you very much, Mr. Chairman.

[The prepared statement of Mr. Waxman follows:]

FRED UPTON, MICHIGAN
CHAIRMAN

HENRY A. WAXMAN, CALIFORNIA
RANKING MEMBER

ONE HUNDRED TWELFTH CONGRESS
Congress of the United States
House of Representatives
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Minority (202) 225-3641

Opening Statement of Rep. Henry A. Waxman
Ranking Member, Committee on Energy and Commerce
"Legislative Hearing to Address Spectrum and Public Safety Issues"
Subcommittee on Communications and Technology
July 15, 2011

Chairman Walden, thank you for convening the hearing this morning to discuss how can we can quickly provide public safety with a nationwide interoperable broadband network and make more spectrum available for wireless broadband. Both goals are critical to our country and require Congress to act quickly and decisively.

In less than 60 days we will observe the tenth anniversary of the terrorist attacks on New York, Washington and over the skies of Pennsylvania.

Construction of a nationwide public safety broadband network remains critical unfinished business, and we should do everything possible to send a bill to the President that accomplishes this bipartisan objective.

After several constructive hearings on spectrum policy, today we will consider a Republican discussion draft. I am pleased that we will discuss specific details about incentive auctions, public safety governance, and federal spectrum relocation, and still hope we can find common ground on several other issues.

In order to highlight our areas of agreement and disagreement, yesterday Representative Eshoo and I released a discussion draft of the Public Safety Broadband and Wireless Innovation Act of 2011. Although many details of the bill we put forward differ from the Republican draft, Democrats on the committee hope we can develop one legislative vehicle that takes the best ideas from both proposals.

Senators Rockefeller and Hutchison did a commendable job on a bipartisan package to empower the FCC to conduct incentive auctions for broadcast spectrum and create a nationwide broadband network for public safety. The Democratic draft builds upon the bipartisan work of the Senate Commerce Committee.

With regard to public safety, committee Democrats believe we must establish a strong governance structure to manage the highly complex undertaking of building and managing an advanced wireless network. Through a non-profit corporation, streamlined to act quickly and efficiently, we have put in place a number of policies and requirements designed to ensure we reach our primary goal of nationwide interoperability for first responders. This corporation would be statutorily required to operate in a fiscally responsible manner and to provide the technical and management expertise this network will need.

Public safety will have a strong voice, but the network will rely heavily on commercial know-how, national standards, and existing infrastructure.

The public safety community has indicated its strong support for the robust governance approach in the Senate bill and in the Democratic draft

It is on the basis of this strong governance model, and public safety's commitment to this approach, that I have come to support reallocation of the D block for public safety's use.

Reallocation is the best way to ensure that public safety has the leverage to incentivize the public private partnerships and network sharing arrangements that are essential to constructing a nationwide broadband network. Moreover, reallocation allows us to plan for public safety's transition to broadband. And the Democratic draft requires the FCC to evaluate opportunities to gain additional efficiencies across all public safety spectrum, including the possible return of spectrum for future auction.

Finally, reallocation is the best chance we have to pass legislation into law. It has bipartisan support in the House and the Senate. The Administration is strongly supportive, and the entire public safety community, including mayors, governors, and numerous other state and local officials, are united on this path forward. In my view, strong governance, oversight, accountability, and smart spectrum management provide us with a good solution.

Although we have disagreements about the D block, the specifics of a governance model, and funding, Democrats and Republicans are not far apart on other details. We all agree that we need to leverage commercial networks, ensure that the public safety equipment market becomes more competitive, and allow state and local officials to play a significant role in the development of this network.

We also have found a good amount of common ground on spectrum policy. Both Democrats and Republicans want to enable the FCC to conduct voluntary incentive auctions that are fair to broadcasters. We want the FCC to have sufficient flexibility to make auctions successful, although we have slightly different approaches to providing that flexibility. We don't agree on the future of unlicensed spectrum or on limiting the FCC's ability to impose conditions on spectrum licenses in the future – we would prefer that these decisions should be made by the expert agency based on market conditions and other factors.

I would like to thank our witnesses for being here and look forward to your testimony.

Thank you.

Mr. WALDEN. Thank you, sir. We appreciate your comments. We will continue to work together on this.

I would like to now turn to our panel of witnesses, and we will lead with the chief of police, San Jose Police Department, Mr. Christopher M. Moore, who had a wonderful transportation system getting him here. We appreciate you making it all the way through. Thank you, sir. And we welcome your testimony.

STATEMENTS OF CHRISTOPHER M. MOORE, CHIEF OF POLICE, SAN JOSE, CALIFORNIA; PETER CRAMTON, PROFESSOR OF ECONOMICS, UNIVERSITY OF MARYLAND; HON. GORDON H. SMITH, PRESIDENT AND CEO, NATIONAL ASSOCIATION OF BROADCASTERS; MICHAEL A. CALABRESE, DIRECTOR, WIRELESS FUTURE PROJECT, OPEN TECHNOLOGY INITIATIVE, NEW AMERICA FOUNDATION; AND CHRISTOPHER GUTTMAN–MCCABE, VICE PRESIDENT, REGULATORY AFFAIRS, CTIA–THE WIRELESS ASSOCIATION

STATEMENT OF CHRISTOPHER M. MOORE

Mr. MOORE. Good morning, and thank you, Chairman Walden and Ranking Member Eshoo. My name is Chris Moore. I am the chief of police for the City of San Jose Police Department in California. I am one of the representatives of the Major City Chiefs Association to the Public Safety Alliance, which is a coalition of leading public safety associations that represent every law enforcement, fire, EMS, emergency management agency and first responder organizations in the country.

My comments today will be brief and to the point. I am here on behalf of the PSA and millions of first responders across the country to ask for your support of companion legislation that came out of the Senate, S. 911, the Public Safety Spectrum and Wireless Innovation Act of 2011, which was recently and overwhelmingly passed by a 21-to-4 bipartisan vote by your counterparts in the Senate Commerce, Science and Transportation Committee.

This act does what public safety and State and local governments have requested Congress to sponsor and support as a top priority for more than 2 years. This legislation allocates the D-block to public safety; provides necessary funding for the build-out of a nationwide public safety broadband network, especially in rural areas; and establishes the governance to oversee and manage the build-out, maintenance, operation and upgrade of a network for decades to come. We urge the committee to act now as if a 9/11 or a Hurricane Katrina event were to have occurred just yesterday and fulfill the last recommendation of the 9/11 Commission by allocating the D-block, as recently endorsed in testimony this year by the cochairs of the 9/11 Commission.

The PSA is greatly encouraged by the Democratic discussion draft that was circulated by Congresswoman Eshoo and Congressman Waxman just this week, and we urge swift introduction and committee consideration to move this matter to the House floor. The PSA strongly believes that this language, as developed within the committee of jurisdiction, builds and improves upon H.R. 607, which has garnered bipartisan support of 43 cosponsors so far this year. Indeed, legislation to allocate the D-block to public safety introduced in the House in the 111th Congress last year garnered 80 bipartisan cosponsors.

Mr. Chairman and members of the committee, the PSA representatives have testified before this committee as recently as this April and May to press for a nationwide public safety broadband network. We emphasize that this is a unique and truly one-time opportunity to change our operations of the past, a past highlighted by trying to, quote, make due by linking and patching together communication systems on thin slices of spectrum spread out over at least six different bands in order to acquire interoperability and achieve spectral efficiency.

We also stressed the need for adequate capacity of a network with public safety control and mission-critical capabilities from the outset. The PSA strongly believes that allocation of the D-block with funding is the only proposal that establishes those baseline principles and needs. We need the upfront funding to jump-start investment and build out of the network, and to attract and encourage commercial interests and competition. We will partner with the private sector, with utilities and with critical infrastructure to leverage and to make maximum use of existing infrastructure that exists today. We do support a strong governance structure as proposed in the Senate's bipartisan bill, S. 911.

Mr. Chairman, the majority staff discussion draft, as currently written, does not meet those conditions as we have outlined previously in both the House and in the Senate. In fact, if passed into law as currently written, it would leave the public safety worse off than it is today. Mr. Chairman, we cannot support that draft legislation.

While the PSA is opposed to the majority's discussion draft on key points, including one, the auction of the D-block; two, multistate licensing; three, the governance structure; and, four, the lack of specified funding as the top priority of any auction proceeds, we do appreciate the ongoing dialogue and consideration of our views, experience and perspective.

And on a personal and professional note, I would like to thank the staff members from both sides of the aisle, whether they were in the majority or in the minority, for their steadfast and thoughtful discussions with public safety over the last 2 years.

We are committed to continuing to work with the committee to bring to the floor a bill in the House to achieve the final enactment of legislation on this critical matter this year. Indeed, the PSA continues to seek enactment before the 10th anniversary of the tragic events of 9/11.

Over the past 2 years, numerous hearings have been held on public safety spectrum and a nationwide public safety broadband network by this committee in addition to the Homeland Security Committee; the Senate Homeland Security and Government Affairs Committee; the Senate Commerce, Science and Transportation Committee. Congress has asked many good questions, and we in public safety and State and local government have worked hard to provide you with answers. We are not here asking for the spectrum and funding to make a profit. We are not here asking for the spectrum and funding for some personal gain or reward. We are here asking for spectrum and funding in order for us to better serve and protect the American people. We are here to make sure that our first responders who do put their lives on the line every day have the resources they need to do their jobs more efficiently and effectively, armed with real-time data, video and other information that can only be accessed in the latest and best mobile broadband technology.

I am here to let you know that the Public Safety Alliance will strongly oppose any legislative action that will require auctioning the D-block. This is not an acceptable solution and ignores everything we have been advocating long before 9/11. Auctioning the D-block will put public safety at risk and will considerably limit our first responders' ability to do their jobs.

In conclusion, I would like to thank you for your continued time and commitment to finding a solution that will meet the communication needs of our first responders for decades to come. The time has come for Congress to act, and we urge that you pass legislation before the 10th anniversary of 9/11. And I will be happy to answer any questions that you have.

[The prepared statement of Mr. Moore follows:]

Public Safety Alliance
Dedicated to First Responders...First

Written Testimony of Christopher Moore
Chief of Police, San Jose, CA

before the

House Energy and Commerce Committee
Subcommittee on Communications and Technology

Legislative Hearing to Address Spectrum and Public Safety Issues

July 15, 2011

International Association of Chiefs of Police | International Association of Fire Chiefs
National Sheriffs' Association | Major Cities Chiefs Association
Major County Sheriffs' Association | Metropolitan Fire Chiefs Association
Association of Public-Safety Communications Officials International
National Emergency Management Association | National Association of State EMS Officials

www.psafirst.org

Thank you, Chairman Walden and Ranking Member Eshoo. My Name is Chris Moore, and I am the Chief of Police for the San Jose, California Police Department. I am also one of the representatives of the Major Cities Chiefs Association (MCCA) to the Public Safety Alliance (PSA), which is a coalition of the leading national public safety associations that represent every law enforcement, fire, EMS, emergency management agency and first responder organization in the country.

My comments today will be brief and to the point. I am here on behalf of the PSA and the millions of first responders across this country to ask for your support of companion legislation to ***S.911: The Public Safety Spectrum and Wireless Innovation Act of 2011***, which was recently and overwhelmingly passed by a 21-4 bipartisan vote by your counterparts in the Senate Commerce, Science and Transportation Committee. This act does what public safety and state and local governments have requested Congress to sponsor and support as a top priority for more than two years. The legislation allocates the D Block to public safety, provides the necessary funding to build out the nationwide broadband network, especially in rural areas, and establishes the governance to oversee and manage the build out, maintenance, operation, and upgrade of the network for decades to come. We urge the committee to act now, as if a 9/11 or Hurricane Katrina event had happened just yesterday, and fulfill the last recommendation of 9/11 Commission by allocating the D block, as recently endorsed in testimony this year by the co-chairs of that Commission.

The PSA is greatly encouraged by the Democratic Staff Discussion Draft that has been circulated by Congresswoman Eshoo and Congressman Waxman just this week, and urges swift introduction and Committee consideration to move this matter to the House floor. The PSA strongly believes that this language, as developed within the committee of jurisdiction, builds and improves upon H.R. 607, which has garnered bipartisan support of forty-three (43) co-sponsors so far this year. Indeed, legislation to allocate D block to public safety introduced in the House in the 111th Congress last year garnered 80 bipartisan co-sponsors.

Mr. Chairman and Members of the committee, PSA representatives testified before this committee as recently as April and May to press for a nationwide public safety broadband network. We emphasized that this is an unique, one-time opportunity to change our operations of the past, a past trying to make do by linking and patching together communications systems on thin slices of spectrum spread out over at least six different bands to acquire interoperability and spectral efficiency. We also stressed the need for adequate capacity of the network with public safety control and mission-critical capabilities from the outset. The PSA strongly believes that allocation of the D block with funding is the only proposal that establishes those baseline principles and needs. We need the upfront funding to jumpstart investment and build out of the network, and to attract and encourage commercial interest and competition. We will partner with the private sector to leverage and make maximum use of existing infrastructure, and we do support a strong governance structure as proposed in the Senate's bipartisan bill, S. 911.

Mr. Chairman, the Majority Staff Discussion Draft, as current written, does not meet those conditions as we have outlined previously both in the House and the Senate. In fact, if passed into law as currently written, it would leave public safety worse off than it is today. Mr. Chairman, we cannot support this draft legislation. While the PSA is opposed to the Majority Staff Discussion Draft on key points including (1) the auction of the D block, (2) the multiple state licensing, (3) the governance structure, and (4) the lack of specified funding as the top priority of any auction proceeds, we do appreciate the ongoing dialogue and consideration of our views, experience and perspective. We are committed to continuing to work with the committee to bring a bill to the floor of the House and to achieve final enactment of legislation on this critical matter this year. Indeed, the PSA continues to seek enactment before the 10th Anniversary of the tragic events of 9/11.

Over the past two years, numerous hearings have been held on public safety spectrum and a nationwide public safety broadband network by this Committee, the House Homeland Security Committee, the Senate Homeland Security and Government Affairs Committee, and the Senate Commerce, Science and Transportation Committee. Congress has asked many good questions, and we in public safety and state and local government have worked hard to provide answers to your questions.

We are not here asking for the spectrum and funding to make a profit. We are not here asking for the spectrum and funding for some personal gain or reward. We are here asking for the spectrum and funding in order for us to better serve and protect the American people. We are here to make sure that our first responders, who put their lives on the line every day, have the resources they need to do their jobs more efficiently and effectively, armed with real-time data, video and other information that can only be accessed with the latest in mobile broadband technology.

I am here also to let you know that the Public Safety Alliance will strongly oppose any legislative action that will require auctioning the D Block. This is not an acceptable solution and it ignores everything we have been advocating long before 9/11. Auctioning the D Block will put the public's safety at risk and will considerably limit our first responders' ability to do their jobs.

We will continue to oppose legislative action that would abandon a single nationwide public safety broadband network, as well as action that would prematurely mandate conversion of our current 700 MHz narrowband voice spectrum to broadband. There are no current broadband LTE technology solutions that will replace our mission-critical voice networks or provide us with unit-to-unit talk capability absent access to a network.

In conclusion, I would like to thank you for your continued time and commitment to finding a solution that will meet the communications needs of our first responders for decades to come. The time has come for Congress to act and we urge you to pass legislation before the 10th Anniversary of 9/11. I will be happy to answer any questions you may have.

Mr. WALDEN. Mr. Moore, thank you for making your position very clear. And we look forward to working with you. I am serious about that.

We are going to go to Dr. Cramton now, professor of economics for the University of Maryland. We are delighted to have you here as well, and we look forward to your testimony.

STATEMENT OF PETER CRAMTON

Mr. CRAMTON. Mr. Chairman and members of the committee, I am honored to appear before you today. My remarks are about spectrum policy, especially a much-needed enhancement, incentive auctions. Incentive auctions would allow the Federal Communications Commission to conduct two-sided auctions, auctions that simultaneously free up encumbered spectrum and put it to its best use.

We are in the midst of a communications revolution. Spectrum is an essential input in this revolution. The success of the revolution hinges on making the best use of this essential resource. From 1994 until today, the FCC spectrum auctions have done a superb job of putting the spectrum to its best use; however, it is becoming increasingly difficult for the FCC to find suitable spectrum to satisfy demand.

The best spectrum for mobile broadband has already been allocated, much of it many decades ago for over-the-air TV broadcasts. In recent decades the value of over-the-air broadcast TV has declined as more and more viewers receive their TV signals via cable and satellite.

At the same time, there has been an explosion in growth and use of smart phones and tablets. These devices use the latest communications technology and do amazing things. These devices are used nearly 24/7 by my students and are fueled by spectrum. This is the future.

This shift in demand away from over-the-air TV and toward mobile broadband has created a huge disparity in value. Spectrum used for mobile broadband generates much more economic value than spectrum used for over-the-air TV; hence the need to reallocate much of the TV spectrum from its current low-value use to the high-value use of mobile broadband. The FCC understands this need and has proposed incentive auctions to accomplish this exchange of spectrum from TV to broadband.

There is a consensus among economists and other experts that incentive auctions are the best approach. Unlike the FCC's prior auctions, the incentive auction is a two-sided auction in which TV broadcasters voluntarily offer to sell some or all of their spectrum rights, and mobile operators bid to buy large blocks of spectrum that the latest technologies require. The FCC plays an essential role in this process, repacking the remaining broadcasters to free up as much spectrum as possible, and then clearing the market at a quantity that maximizes social welfare and guarantees positive revenue for the Treasury.

The simple economics of the incentive auction can be explained with the most basic tool of economics, supply and demand. The supply of spectrum comes from the broadcasters' offers to relinquish spectrum, and the demand comes from the mobile operators who bid for the blocks of spectrum. Once offers and bids are received, the FCC can clear the market at a quantity that generates maximum economic value. Although this may appear simple, the incentive auction is complex in its details and requires a great deal of study by experts to get the important details right. The incentive auction is a new and essential innovation. Its development will have a positive transformative impact both in the United States and worldwide, similar to the impact of the FCC's initial spectrum auctions in 1994.

Let me summarize my main points. The incentive auction is an essential innovation that will provide broad benefits to TV broadcasters, mobile operators, public safety, taxpayers and, most importantly, the vast majority of Americans. The incentive auction will create jobs and stimulate long-term growth for the economy.

The incentive auction is complex. Its design is best left to experts. The FCC has an outstanding record of innovation in the auction arena and requires only limited guidance from Congress. On the basic objectives and principles, it would be a mistake for Congress to prevent the FCC from adopting the best auction design by mandating auction details and other restrictions in enabling legislation. There are such mistakes in the draft legislation, which I note in my written testimony. All of these problematic mandates are easily fixed by omitting the auction details and keeping the focus on basic principles.

It is important to understand that not all constraints are bad. For example, restrictions that promote competition in the auction improve both revenues and efficiency.

Given the FCC's outstanding record in designing and implementing auctions, the legislation should provide the FCC with broad auction authority, focused on basic objectives and principles. To me, there are two key objectives, transparency and economic efficiency. What is needed is a statement of these objectives. Including specific details is apt to do more harm than good.

I urge Congress to adopt streamlined legislation for incentive auctions as soon as possible. Only then can the full benefits of the communications revolution be realized. The time to act is now. Then the FCC can accelerate its work on designing and implementing an innovative auction approach to put the radio spectrum to its best use. Thank you.

Mr. WALDEN. Thank you for your testimony. We appreciate that.

[The prepared statement of Mr. Cramton follows:]

Incentive Auctions and Spectrum Policy

Prepared Testimony of Peter Cramton[1]
Professor of Economics, University of Maryland
Chairman, Market Design Inc.

Before the United States House Committee on Energy and Commerce
15 July 2011

Mr. Chairman and members of the House Committee on Energy and Commerce, I am honored to appear before you today. My remarks are about spectrum policy, especially a much needed enhancement, incentive auctions. Incentive auctions would allow the Federal Communications Commission (FCC) to conduct two-sided auctions—auctions that simultaneously free-up encumbered spectrum and put it to its best use.

We are in the midst of a communications revolution. Spectrum is an essential input in this revolution. The success of the revolution hinges on making the best use of this essential resource. From 1994 until today, the FCC's spectrum auctions have done a superb job of putting the spectrum to its best use. However, it is becoming increasingly difficult for the FCC to find suitable spectrum to satisfy demand.

The best spectrum for mobile broadband has already been allocated, much of it many decades ago, for over-the-air TV broadcast. In recent decades, the value of over-the-air TV broadcast has declined as more and more viewers receive their TV signal via cable and satellite. I personally have not seen over-the-air TV in more than 25 years. Most of my students at the University of Maryland have never seen broadcast TV in their lifetimes.

At the same time, there has been explosive growth in the use of smartphones and tablets. These devices, such as my Droid Charge phone, use the latest communications technologies and software to do amazing things. My phone runs on Verizon's 4G LTE network. It achieves data rates of about 20 megabits per second download and 6 megabits per seconds upload. This is about twice as fast as what most Americans get from their fixed broadband connections according to the OECD Broadband Portal. These devices, which are used nearly 24x7 by my students, are fueled by spectrum. This is the future. And it is available in the US now, thanks to the FCC's successful auction program and Congress' setting a firm deadline for the DTV transition, which freed up the necessary spectrum to let the revolution begin.

This shift in demand away from over-the-air TV and toward mobile broadband has created a huge disparity in value. Spectrum used for mobile broadband generates much more economic value than spectrum used for over-the-air TV—hence, the need to reallocate much of the TV spectrum from its current low-value use to the high-value use of mobile broadband.

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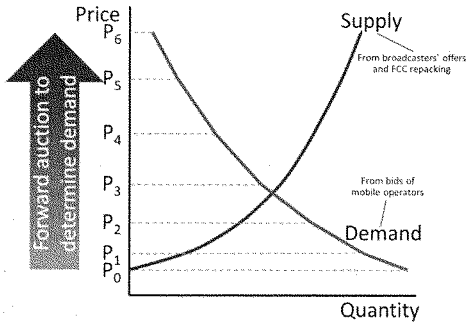
[1] My specialty is the design of complex auction markets. Since 1993, I have contributed extensively to the development of spectrum auctions. I have advised ten governments on spectrum auctions, including the United States. I am currently advising the United Kingdom, Canada, and Singapore. I have advised 35 bidders in major spectrum auctions around the world. I have written dozens of practical papers on spectrum auctions. This research is available at www.cramton.umd.edu/papers/spectrum.

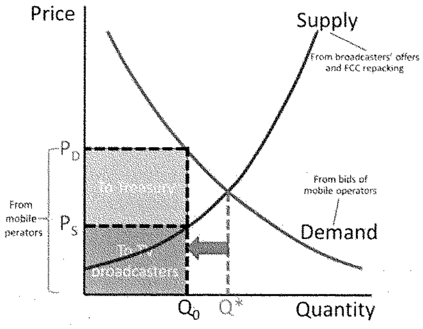
The FCC understands this need and has proposed incentive auctions to accomplish this exchange of spectrum usage rights from TV to broadband. There is consensus among economists and other experts that incentive auctions are the best approach.

Unlike the FCC's prior auctions, the incentive auction is a two-sided auction in which TV broadcasters *voluntarily* offer to sell some or all of their spectrum rights and the mobile operators bid to buy large contiguous blocks of spectrum that the latest communications technologies require. The FCC plays an essential role in the process, repacking the remaining broadcasters to free up as much spectrum as possible and then clearing the market at a quantity that maximizes social welfare and guarantees positive revenue for the Treasury.

The simple economics of the incentive auction can be explained with the most basic tool of economics: supply and demand. The supply of spectrum comes from the broadcasters' offers to relinquish spectrum and the demand comes from the mobile operators' bids for blocks of spectrum, as shown below.



Once offers and bids are received, the FCC can clear the market at a quantity that generates maximum economic value.



Although this may appear simple, the incentive auction is complex in its details and requires a great deal of study by experts to get the important details right. The incentive auction is a new and essential innovation. Its development will have a positive transformative impact both in the US and worldwide, similar to the impact of the FCC's initial spectrum auctions in 1994.

With this background let me summarize my main points.

The incentive auction is an essential innovation. It will provide broad benefits: TV broadcasters, mobile operators, public safety, taxpayers, and most importantly the vast majority of Americans that are participating in this communications revolution. The incentive auction will create jobs and stimulate long-term growth in the US economy.

The incentive auction is complex. Its design is best left to experts. The FCC has an outstanding record of innovation in the auction arena and requires only limited guidance from Congress on the basic objectives and principles.[2] It would be a mistake for Congress to prevent the FCC from adopting the best auction design by mandating auction details and other restrictions in the enabling legislation. There are such mistakes in the draft legislation. Here are a few examples. The current draft specifies:

- a pricing rule for broadcasters that is far from best;
- mandating the treatment of unlicensed spectrum;
- a section on reserve prices that is inconsistent with an effective incentive auction; and
- a sequencing of offers from broadcasters, bids from mobile operators, and repacking by the FCC that appears to be inconsistent with how the incentive auction should be conducted.

All these problematic mandates are easily fixed by omitting the auction details and keeping the focus on basic principles.

Three good features of the draft legislation are worth noting.

- The draft does not impose restrictions on which broadcasters can participate in the auction. Restrictions of this form would weaken competition in the reverse auction among broadcasters.
- The draft avoids restrictions on the revenue division between the Treasury and the broadcasters. The revenue split cannot be established before the auction but only in the last step of the auction, once the supply and demand curves for spectrum have been established in

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[2] Among all US agencies, the FCC gets the highest grade on auction design and implementation. At the other extreme is CMS, which gets the lowest grade among all US agencies for its design and implementation of the Medicare auctions for durable medical equipment. The CMS auction program is certain to fail at considerable cost to taxpayers and Medicare beneficiaries if Congress does not act to replace the current CMS auction with an efficient auction. Unlike the FCC, CMS requires much more direction from Congress. CMS over the last ten years has so far only demonstrated an inability to design and conduct auctions. Specific recommendations to the administration and Congress were provided in a June 2011 letter to President Obama from 244 concerned auction experts, including four Nobel laureates in economics. A wealth of supporting documents on this matter is available at www.cramton.umd.edu/papers/health-care. Like incentive auctions, Medicare auctions are of great importance to this committee; like incentive auctions, Congressional action is required and the proper course is clear.

the auction. Both social gain and revenues are apt to be larger if the only revenue constraint is that the auction generate positive revenue.

- The draft does not impose an unrealistic timeline. There is much design and implementation work to be done by experts. This work together with the regulatory process will take about two years to complete. A faster schedule will prevent the FCC from identifying and implementing the best design. As a result, revenues and social welfare would be lost.

It is important to understand that not all constraints are bad. For example, restrictions that promote competition in the auction improve both revenues and efficiency.

Given the FCC's outstanding record in designing and implementing auctions, the legislation should provide the FCC with broad auction authority, focused on basic objectives and principles. To me, there are two key objectives: 1) transparency and 2) economic efficiency. What is needed is a statement of these objectives. Including specific details is apt to do more harm than good.

I urge Congress to adopt streamlined legislation for incentive auctions as soon as possible. Only then can the full benefits of the communications revolution be realized. The time to act is now. Then the FCC can accelerate its work on designing and implementing an innovative auction approach to put the radio spectrum to its best use.

References

Cramton, Peter, "700 MHz Device Flexibility Promotes Competition," July 2010. Argues that the carrier-specific band plans adopted by AT&T and Verizon Wireless for the 700 MHz paired spectrum will undermine competition. Filing to the FCC on behalf of the Rural Cellular Association.

Cramton, Peter, "Incentive Auctions," Working Paper, University of Maryland, July 2011.

Cramton, Peter, Evan Kwerel, Gregory Rosston, and Andrzej Skrzypacz "Using Spectrum Auctions to Enhance Competition in Wireless Services," *Journal of Law and Economics*, 54, forthcoming, 2011.

Cramton, Peter, "Spectrum Auction Design," Working Paper, University of Maryland, June 2009.

Letter from 112 economists to President Obama, urging legislation that gives the FCC explicit authority to conduct incentive auctions, 6 April 2011.

Letter from 244 economists to President Obama, urging legislation that reforms CMS' auction program for durable medical equipment, 17 June 2011.

Mr. WALDEN. We are going to turn now to the Honorable Gordon Smith, president and CEO of the National Association of Broadcasters. Senator, we are delighted to have you back before the committee. We look forward to your testimony.

STATEMENT OF HON. GORDON H. SMITH

Mr. SMITH. Thank you, Mr. Chairman, Ranking Member Eshoo, members of the subcommittee. My name is Gordon Smith. I am president and CEO of the NAB. Thank you for inviting me here today to discuss your draft spectrum legislation and in particular the voluntary incentive auction provisions.

Mr. Chairman, let me tell you at the outset that the NAB is heartened that this discussion draft recognizes the need for a balance in raising revenues for the Treasury, in making spectrum available for wireless broadband, and in protecting television viewers and broadcasters through the process of voluntary incentive auctions.

Of course, intrinsic in the word "voluntary" is the notion that you will not be penalized for not participating. Ensuring incentive auctions are voluntary is of paramount importance to the NAB. So first and foremost, let me tell you that broadcasters appreciate the inclusion of the concept of truly voluntary incentive auctions in your draft.

While participation in an auction is voluntary, the subsequent repacking of broadcast stations to new channels following the auction is not voluntary. Based on the spectrum goal set by the FCC in the National Broadband Plan, a total of 672 full-power stations, including commercial and noncommercial stations across the United States, would be forced onto a new channel. That is nearly 40 percent of all TV stations in America. Contrast that with 174 stations that were cleared from the spectrum during the DTV transition. I know my phones lit up in my Senate office just with that. Imagine the 672.

Clearly this new round of repacking would result in significant disruption and confusion for our viewers and your constituents, who recently went through that DTV transition. For this reason we have focused on four elements that NAB believes must be included in any voluntary incentive auction to protect both television viewers and broadcasters.

We ask that broadcasters be given the same opportunity as other industries to innovate with our spectrum, which means preventing the FCC from involuntarily moving stations from the U to the V band. Your legislation does that.

We ask that legislation provide certainty to broadcasting and that those investing in broadcasting by requiring or permitting one auction so that this doesn't happen year in, Congress after Congress, year in and year out. Your proposal achieves that, Mr. Chairman.

We ask for reimbursement for station costs associated with relocating broadcast stations, and your legislation does that as well. But we may ask your indulgence for a slight adjustment in the language to achieve the goal of holding harmless those who did not participate in the auction.

Finally and most importantly, we ask that legislation preserve viewer access to over-the-air signals by replicating existing station service areas and covered populations. We also want to ensure that signals reach cable and satellite head-ins that rely on over-the-air delivery so that viewers continue to receive their broadcast channels. To this point, we believe the bill's language could use a little bit of enhancement, because as drafted, the FCC is required to make reasonable efforts to preserve viewer access to over-the-air.

I underscore the importance of having access to broadcast channels when we see weather seasons like we are currently having, when tornadoes are literally ripping through communities. While public safety is the first responder, broadcasting is the first informer. And so as you help one, our brethren and sisters and first responders, don't hurt the first informers. We are partners in public safety. So we ask that. We thank you for that.

And then to this point, and frankly to the professor's point, of highest and best use, what is the value of a soul when a tornado is ripping through his or her community; when their only access is not this, it is their television set or their radio? Broadcasters is the one thing that stays up and on the air, and which can literally be the difference of life and death and getting the information to the first responders. That is what I think highest and best use must include, not just purely an economic supply-and-demand calculation.

For this reason, we prefer language that directs the FCC to preserve viewer access to stations to the maximum extent possible. I don't think that is unreasonable, given the stakes. Because the broadcasters have the benefit of experience in the repacking process used during the DTV transition, we ask that the final bill include a requirement that the FCC utilize the same protection criteria, the same protection criteria used in the final table of allotments for digital television service.

Before I conclude, let me take a moment, Mr. Chairman, to thank Chairman Emeritus Dingell and Congressman Green for their work in also putting together a strong bill that protects viewers and broadcasters through the incentive auction process, as well as Ranking Members Waxman and Eshoo for their spectrum bill released just yesterday. We appreciate the fine work of all on both sides of the aisle trying to get this balance right. And this is a most important issue. It does involve economics. It involves life and death as well.

And so I would like to introduce into the record two letters, one from America's 50 State broadcaster associations to the House leadership, a second letter from the 4 network-affiliated associations to House leadership. Thank you again, Mr. Chairman.

Mr. WALDEN. Without objection, they will be entered into the record.

[The prepared statement of Mr. Smith follows:]

NAB
NATIONAL ASSOCIATION OF BROADCASTERS

"Legislative Hearing to Address Spectrum and Public Safety Issues"

United States House of Representatives
Subcommittee on Communications and Technology

July 15, 2011

Statement of Senator Gordon H. Smith
President and Chief Executive Officer
National Association of Broadcasters

Good morning Chairman Walden, Ranking Member Eshoo and members of the Subcommittee. My name is Gordon Smith, and I am President and CEO of the National Association of Broadcasters ("NAB"). NAB is a nonprofit trade association that advocates on behalf of thousands of local radio and television stations and broadcast networks before Congress, the Federal Communications Commission ("FCC") and other federal agencies, and the Courts.

I am grateful for the opportunity to speak before you this morning about broadcasters' use of spectrum and public safety. As you are all aware, this is a time of great and rapid change in all sectors of the communications industry, including broadcasting. Two years removed from the transition to all-digital television, local full power TV broadcast stations have embraced digital technology to use their 6 MHz channels more intensively and expand greatly the amount and quality of free television available to local citizens. Because of digital, broadcasters now offer twice as many channels as they did in the analog world while at the same time returning 108 MHz of spectrum for use by others, including the public safety community. They offer programming, for free, in high definition. They are just now bringing highly-anticipated Mobile DTV to market. And these advances are just the beginning. Over the course of the next decade, TV broadcasters will introduce a variety of new ways to provide highly valued information and entertainment to viewers, however and wherever they want it using their efficient one-to-many architecture.

Despite these changes, broadcasters continue to do what they have always done for their local communities. They are still the go-to source for local news. They are still the primary method to alert citizens during emergencies. And they are still the most viewed medium for addressing issues that impact our lives and neighbor's lives. And no new technology – not the Internet, not the smartphone, not the tablet – has stepped in to replace broadcaster's critical role in this regard.

This is due, in part, to the nature of broadcast delivery. As I will explain more fully, broadcast architecture is a one-to-many model that is infinitely scalable to additional users. This is critical during emergencies, when many people want and need access to the same information at the same time. Compare this to the one-to-one architecture of wireless phone and broadband services, which is susceptible to network failure when traffic surges, as it does during an emergency. It shuts down just when people need it the most. Broadcast technology does not shut down because of traffic surges. It thrives when people need it the most.

As this Subcommittee and Congress move forward with possible incentive auction legislation, we urge you to be mindful of the critical role broadcasters continue to play in the communications ecosystem. Millions of viewers rely on local stations for news, for entertainment, and most germane to this hearing, for their safety when disaster strikes. Spectrum policies, including potential incentive auction legislation, that seriously diminishes the local broadcast service will disenfranchise millions of TV viewers and could well endanger those viewers during emergencies.

To avoid those harms, it is critical that any incentive auction legislation be crafted to ensure viewers who rely on broadcast television continue to receive the service they do today. I want to thank the leadership of this Committee, in particular Chairman Upton and Chairman Walden, for the solid framework incorporated in the discussion draft being deliberated on today. I also want to thank Representatives Dingell and Green who introduced H.R. 2482, another comprehensive approach to spectrum policy that works to protect households that rely on over-the-air TV. As your colleague Representative Green can attest, 42% of the Hispanic population in Houston relies exclusively on this vital service, while 1 out of 4 Hispanic households nationwide are over-the-air exclusively. Couple this with the approximately 46 million Americans relying solely on this free service, and, clearly, it is essential we get this right.

In the next few weeks and months, as this Committee begins the legislative process to craft balanced spectrum policy, we ask that you not only further consider the impact that spectrum inventive auctions could have on viewers and on emergency communications, but also the significant impact this shift in spectrum policy would have on the future of telecommunications. It is a shift, in part, from a free information service to a paid service. It is the likely shift from spectrum licensed to hundreds of companies to a handful. And it is an irreversible shift from a one-to-many architecture to a one-to-one architecture – potentially impacting our ability to reach citizens with vital emergency information.

I. Radio and Television Broadcasters' Role as "First Informers" Ensures Timely and Continuous Information during Emergencies and Disasters

Broadcasters have long earned recognition for their service during emergencies and disasters by providing the public with effective warnings, and reporting critical information as events unfold. As noted in the FCC's recent *Future of Media* Report, "during emergencies, the local TV station is often considered to be as vital a part of the local community as the police and fire departments."[1] Broadcasters take their role as

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[1] Steven Waldman, *The Information Needs of Communities: The Changing Media Landscape in a Broadband Age,* at 79 (June 2011) ("The Future of Media Report").

"first informers" very seriously. In the last few years, local stations' commitment to emergency services has proven itself time and again as communities across the country have been struck by disaster.

Here are just a few examples:

- A survey conducted of Alabama residents impacted by the tornados that struck in late April 2011 reported that 71% of adults received early warning of the tornados by watching television.[2] An additional 10% of those surveyed learned of the tornados via radio. A mere 6% of respondents learned of the tornados through Internet, smartphones, or Twitter/Facebook. *Id.*
- As a dangerous storm developed near Springfield, Massachusetts, last month, all three local television stations went wall-to-wall with coverage. In an area not used to tornadoes, the stations captured dramatic images and broadcast them to viewers. Following the storm, the stations continued to report on the damage and recovery and provided information on relief and food supplies.[3]
- Prior to tornados striking Joplin, Missouri in May, radio station KZRG began wall-to-wall coverage to alert residents about the storm an hour and a half before the twister touched down.[4] When Internet and mobile connections were unreliable following the tornado, Zimmer Radio, owner of KZRG, broadcast a single feed of continuous disaster coverage on six radio stations. *Id.* Crews drove to the station immediately after the tornado in order to provide information on medical help, the missing, and where residents could buy gas and groceries. *Id.*
- During the blizzards that hit the East Coast in February 2010, which effectively closed down the nation's capital for four days, broadcasters provided up-to-the-minute information that was critical to affected residents. Washington D.C. station WRC-TV's wall-to-wall coverage and "potentially life-saving newscasts" were lauded by Maryland Senator Barbara Mikulski, and stations WJLA-TV and WUSA also earned praise

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[2] Alabama Tornado Survey, Billy McDowell, VP of Media Research RAYCOM Media, May 2011.

[3] Scott Fybush, "Radio, TV React to Mass. Tornadoes," *NorthEast Radio Watch* (June 6, 2011).

[4] Moni Basu, "Radio Stations Chug Along 24/7 in Tornado-devastated Joplin" May 24, 2011, CNN, available at http://articles.cnn.com/2011-05-24/us/missouri.tornado.radio_1_radio-stations-killer-tornado-deadly-tornado?_s=PM:US

> for their coverage of the snowstorms.[5] FCC Chairman Julius Genachowski observed that "not only were local broadcasters a lifeline for the community, WRC-TV used its robust Web site and Twitter feed to help residents who had lost power get up-to-the-minute information through their computers and phones."[6]

Despite the growth of wireless services, including broadband, broadcasting continues to be relied upon throughout the world as the principle means of communicating with the public before and after disasters. One example from Japan following the devastating earthquake and tsunami in March shows the impact of mobile broadcasting as an alerting mechanism. More than 75 percent of mobile phones in Japan include a mobile DTV chip and the service is actively used by more than 40 percent of the population.[7] In the moments after the earthquake hit Japan, television stations began broadcasting tsunami warnings. Individuals without access to a television, or who lost power, were able to watch these warnings and other information about the unfolding events via their mobile phones.[8] As one resident noted: "It's very convenient being able to watch live TV when the phones are down. Otherwise, we'd have no idea what is going on." *Id.* And in this country, local television stations remain the leading source for weather information.[9]

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[5] John Eggerton, "As the Snowy World Turns," *Broadcasting & Cable* (Feb. 10, 2010).

[6] Prepared Remarks of Chairman Julius Genachowski, NAB Show 2010, Las Vegas, Nevada at 2 (Apr. 13, 2010).

[7] *See* Heather Fleming Phillips, "Free is the Key To Mobile DTV Success," TVNewsCheck (March 9, 2011), available at http://www.tvnewscheck.com/article/2011/03/09/49663/free-is-the-key-to-mobile-dtv-success.

[8] WALL STREET JOURNAL *Live Blog: Japan Earthquake,* March 11, 2011 3:06 AM JST http://blogs.wsj.com/japanrealtime/2011/03/11/live-blog-japan-earthquake/tab/liveblog/.

[9] Radio & Television Business Report, "Poll finds local television is leading source for weather info" (Jan. 4, 2011).

Local broadcasters can also bring another dimension to alerting the public – their newsrooms. Unlike wireless carriers, local broadcasters both create and distribute content. Television and radio stations, located in their viewing and listening areas, are uniquely positioned to provide up-to-the-minute information on emergencies and disasters. Many local television stations employ highly sophisticated weather tracking systems that can provide detailed information on severe weather, including tornados.[10] Thus, while broadcasters applaud and support Congressional efforts to help launch a cell-based warning system, we hope that Congress recognizes that such a system is a complement to, not a substitute for, the information and services provided by broadcasters. No text-based technology with limited space for information or data can replace the extensive and detailed information offered by broadcasters, as well as the reassuring impact of a human voice in emergency situations.

II. The "One-to-Many" Broadcast Architecture Is More Robust Than the "One-to-One" Broadband Architecture for Delivery of Critical Information During Emergencies

Because of the differences in their network architecture, wireless networks are simply not as durable as broadcasting during emergencies. The architecture of cellular network technology – a one-to-one, node-based structure – is ideally suited for interactive communications, but lacks robustness under heavy usage, which typically occurs in emergency situations. Broadcasting's one-to-many architecture, in contrast, cannot be overwhelmed by increased usage.

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[10] Broadcasters' investments in emergency journalism are significant. *See The Economic Realities of Local Television News – 2010*, attached to NAB Comments in GN Docket No. 10-25 (filed May 7, 2010)(reporting that a single season's hurricane coverage cost one television station $160,000 *before* accounting for lost advertising revenue, and that another television station lost 50 percent of its revenue for an entire month following the September 11 attacks because intensive news programming preempted so much regular programming) ("NAB Future of Media Comments").

When Hurricane Katrina made landfall on August 29, 2005, cellular infrastructure in New Orleans was devastated.[11] The few cellular towers that survived were overloaded by residents attempting to make phone calls.[12] When phone networks failed and residents of New Orleans were cut off from the rest of the world, they "huddled around battery-operated devices, seeking comfort and news from the on-air voices."[13] During the crisis that followed in the aftermath of Hurricane Katrina, several radio stations were able to continue broadcasting,[14] and television stations WWL-TV and WDSU(TV) continued to broadcast despite the disaster by using transmitters in Baton Rouge, Houston and elsewhere. Less than a month later, Hurricane Rita hit the Gulf Coast, and KLFY, a Lafayette, Louisiana television station, provided continuous live coverage when the path of the hurricane was determined to pose a risk to people in the station's service area.[15]

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[11] Marguerite Reardon, *Why Cell Phone Networks are a Weak Link in a Crisis*, CNET NEWS, Aug. 2, 2007. Available at http://news.cnet.com/8301-10784_3-9754096-7.html.

[12] Tom Conlon, *Bridge Collapse: Why Did Cell Phones Fail?*, SWITCHED, Aug. 3, 2007. Available at http://www.switched.com/2007/08/03/bridge-collapse-why-did-cell-phones-fail/?feeddeeplinkNum=0.

[13] *Good Morning, New Orleans*, NEWSWEEK, Sept. 21, 2005, at 14.

[14] *See* Reginald F. Moody, *Radio's Role During Hurricane Katrina: A Case Study of WWL Radio and the United Radio Broadcasters of New Orleans*, JOURNAL OF RADIO & AUDIO MEDIA, 16 (2), p. 160-180, at 164 (2009).

[15] *See* NAB Future of Media Comments at 15.

Similarly, in the hours and days following the recent devastating tornado in Joplin, Missouri, "[t]elephone lines were down" and "[c]ell phones didn't work."[16] In sharp contrast, local broadcast stations were able to continue broadcasting without interruption. *Id.* And during this spring's deadly tornados in Alabama, Birmingham's television and radio stations remained on the air, and the Birmingham City Newspaper observed that:

> Local television was the primary source of news about the rapidly changing afternoon weather patterns [prior to the tornado that hit Tuscaloosa, Alabama]; not social media or text alerts—television. Social media amplified and carried the message, but TV meteorologists brought us the info forward.
>
> Though anyone with a computer can access real-time weather data from most of the same sources as local meteorologist James Spann and company, we often rely on their televised expertise to know when to hide in the basement. Their coverage likely saved hundreds of lives.[17]

Why have wireless networks proven to be less robust than broadcast systems during these various crises? The point-to-point architecture of wireless broadband networks essentially means that each user has his or her own path in the cellular network. This type of design allows two people standing next to each other using the same type of device and operating on the same wireless network to access totally different types of information. The first person can be watching a video and the second person can be looking up directions to the closest Chinese restaurant. But, if those two people and hundreds or thousands of other people near them are trying to access the same information at the same time – like they may well during an emergency – the wireless network will quickly be overwhelmed. And, no amount of additional spectrum or other redundancy can overcome this issue.

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[16] Jay Scherder, *Radio Station Connects Joplin Tornado Victims After Other Communications Were Cut Off*, KY3 NEWS, May 25, 2011. Available at http://www.ky3.com/news/ky3-radio-station-connects-joplin-tornado-victims-after-other-communications-were-cut-off-20110525,0,7257538.story.

[17] Wade Kwon, "Twisters, Twitter, and You," *Birmingham's City Paper* (May 12, 2011).

Mobile device connections begin with a link between a user's mobile device and a base station (often a cell tower).[18] These base stations cover a certain geographic area and receive all data transmitted from mobile phones within that geographic area. The base station then transmits the data (in the wireless broadband context, this data is often a small packet requesting data be sent to the mobile phone) to a mobile switching center. The mobile switching center connects the data to a transmission network where the data is sent to its final destination. *Id.* The data requested by the user is then sent through the same transmission network and back through the mobile switching center. From there, the data is sent to a base station that transmits the data to the individual's mobile phone. *Id.*

With this unicast design, a base station needs to send data to every mobile phone individually, even if those phones are accessing the same data (as they would during an emergency). This creates a serious risk of overloading the cell network when too many people attempt to access the network at the same time.[19]

In contrast, television and radio broadcasting creates one or just a few data streams and transmits that data over a specific geographic area using a high-powered transmitter. This data can be received by anyone who has a receiver located within the transmission range of that broadcaster. Since there is no uplink or return path in the broadcasting model, no stress is put on the broadcasting network. Therefore, a broadcaster's data stream will continue, uninterrupted, regardless of how many individuals decide to view or listen to the broadcast. Because of this ability to blanket "an unlimited number of users with the same information" simultaneously, without delays or "clogs," it has even been observed that "homeland security depends on broadcast." *Id.*

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[18] D. Tipper, S. Ramaswamy, T. Dahlberg, *PCS Network Survivability*, *Proceedings of the IEEE Wireless Communications and Networking Conference 1999,* New Orleans, LA, Sept., 1999.

[19] *See* Tom Wolzien, "Homeland Security Depends on Broadcast," *TVNewsCheck* (April 4, 2010)(observing that "broadband circuits – wired or mobile – can clog up and the information-carrying data can't pass" when "many people need something at the same time").

We note that, theoretically, a cellular network provider could build a system capable of handling the increased cellular and broadband traffic that accompanies emergency situations. Building thousands of extra base stations, mobile switching centers and other excessive redundancies could be sufficient to handle extreme spikes in data requests. However, it is simply not realistic, as a financial or practical matter.[20] According to Heidi Flato, a spokesperson for Verizon Wireless in Northern California, it is not practical to build a cellular network for emergency situations.[21] "To build for that sort of need, for that sort of circumstance, it's like building a second [San Francisco] Bay Bridge just in case the first one falls down," she said. *Id.* Consequently, wireless services, including broadband, will likely remain a supplement to, and not a replacement for, broadcasting during emergencies.

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[20] For instance, one can only imagine the zoning and environmental issues (as well as the reaction of many members of the public) associated with building thousands of additional base stations and switching centers.

[21] Todd R. Weiss, *In Emergencies, Can Cell Phone Network Overload be Prevented?*, COMPUTERWORLD, Nov. 5, 2007. Available at http://www.computerworld.com/s/article/9045438/In_emergencies_can_cell_phone_network_overload_be_prevented_?taxonomyId=15&pageNumber=1.

III. No Spectrum Legislation Should Diminish Viewers' Ability to Receive Emergency Information, News or Free Entertainment

As explained above, broadcast technology is, and will continue to be, the optimal method for reaching mass audiences during emergencies. For these reasons, Congress should carefully consider the impact that reallocating spectrum from free over-the-air television to paid cellular networks will have on the ability of citizens to receive emergency information, now and in the future. It should also avoid policies that might limit broadcast innovations that could substantially aid in emergency communications, particularly Mobile DTV.

To ensure that any spectrum incentive auction and subsequent repacking of stations does not disenfranchise viewers, Congress should consider the following four principles when drafting legislation.

1. Preserve viewer access to over-the-air signals by replicating existing station service areas and limiting interference.
2. Do not force broadcasters into an alternative band. UHF stations should stay in the UHF band and no station should be forced into the low VHF band. This is critical for the development of Mobile DTV.
3. Provide certainty to TV viewers and broadcasters by limiting FCC authority to holding only one incentive auction for television spectrum. Multiple auctions would be very disruptive to viewers and would devastate investment in the industry.
4. Hold harmless and make whole those broadcasters that choose not to volunteer for the auction but who must bear the substantial cost of relocating to a new channel.

Let me explain each of these four principles in more detail.

a. Preserve viewer access to over-the-air signals by replicating existing station service areas and limiting interference

First and foremost, viewers should not be disenfranchised. Viewers that receive signals today should receive signals from the same television stations with the same level of service if the FCC repacks remaining stations into a smaller television band following an incentive auction. This means that the service area of repacked stations should be at least as great as those stations had before, and that viewers should not experience any additional interference to their reception of TV signals.

Live, local and free television is especially heavily relied upon by lower income viewers and by Hispanic, African-American and Asian households, who are less likely than the general population to subscribe to pay television services. Any reduction of over-the-air broadcasting would thus negatively affect some of our most vulnerable populations, who could lose access to the services that broadcasters provide, including local news and emergency information.

We also observe that viewership of over-the-air (OTA) television is increasing generally. Knowledge Networks – a well-respected research firm – recently released a survey that shows the number of Americans who rely solely on free over-the-air broadcasts is approximately 46 million -- up by 4 million from just a year ago.[22] Much of this increase likely is driven by "cord cutting," an undeniable phenomenon that finds users, many of them younger than 25, opting for free OTA television, supplemented by IP-delivered video. These cord cutters are able to receive essential programming, like local news and emergency information, without a subscription and, most importantly, for free. Tech-savvy cord cutters recognize that services like Netflix alone cannot support all of their video needs. They want live, local television. They want major sporting events including the Olympics and the Super Bowl. And they want high-quality network programming. Many are surprised to find that they can get it all with just an antenna. Together, over-the-air TV and online services represent a strong competitor to increasingly expensive cable and satellite providers.

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[22] Knowledge Networks, Press Release, "Over-the-Air TV Homes Now Include 46 Million Consumers" (June 6, 2011).

Given the demographics of cord cutters, this trend should continue for some time, unless incentive auction legislation allows the FCC to decrease broadcast service areas and effectively forces some viewers to use paid services. We urge Congress to protect all viewers who rely on OTA television by ensuring that any spectrum reallocation does not decrease broadcast service areas or increase interference.

b. Do not force broadcasters into an alternative band or to share channels with other broadcasters

To ensure that local television viewers benefit from the $15 billion digital transition going forward, Congress should ensure that no station is forced to share a channel with another station or required to move to a channel in a different band. In other words, stations operating currently in UHF should continue to do so. Likewise, no station operating as a high VHF station (channels 7-13) should be forced onto a low VHF channel (channels 2-6). If possible, however, those VHF stations should be permitted to move to UHF channels.

To provide a viable product that will satisfy consumer needs, broadcasters must have access to spectrum free of signal interference. If, as part of the television band reallocations, stations are moved from the UHF band to the VHF band, the deployment of mobile DTV will be severely limited. It is well established that operating Mobile DTV in the VHF band is very challenging and virtually impossible in low VHF where ground noise causes harmful interference.[23] In light of the role that Mobile DTV has played in recent emergencies in other countries, such limitation on the deployment of Mobile DTV would not be in the public interest.

Beyond its clear role in emergency communications, Mobile DTV is also a product that consumers desire for entertainment and news. According to a 2009 study, 88 percent of consumers are interested in watching local news and information on a mobile device.[24] More and more, consumers are looking for opportunities to watch their favorite programming wherever they are and on whatever device they choose – on their phones, in their cars, on their tablets. Mobile DTV will fill that demand without taxing existing or future wireless broadband networks. As more wireless companies end unlimited data packages, it is likely that consumers will shy away from data-heavy uses like video delivered through wireless networks. Mobile DTV services will be there to fill that void with news, high-quality entertainment programming, on-the-go weather and sports, and more – all without the threat of an unwelcome surprise on a consumer's wireless bill.

Additionally, other proposals, such as forced channel-sharing or spectrum fees, would negatively impact broadcasters' ability to provide mobile and other services. Limiting broadcasters to 3 MHz or less of spectrum per station would require them to make the Hobson's Choice between providing a proper high-definition primary channel with no mobile DTV feed and a standard definition primary channel with perhaps one mobile DTV feed. Channel sharing would also clearly inhibit the ability of local stations to multicast additional streams of free OTA programming, including content specifically targeted to diverse and niche audiences.[25] In short, such a limitation will severely limit broadcasters' opportunity to develop a market for mobile or multicast services, to compete against other video services likely to be offered by wireless providers, and to provide important emergency alerts and information via mobile DTV services.

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[23] *See Innovation in the Broadcast Television Bands: Allocations, Channel Sharing and Improvements to VHF*, Notice of Proposed Rulemaking, ET Docket No. 10-235, 25 FCC Rcd 16498 at 16512 (Nov. 30, 2010).

[24] *See* Frank N. Magid Associates, Inc., *The OMVC Mobile TV Study: Live, Local Programming Will Drive Demand for Mobile TV*, available at www.openmobilevideo.com/_assets/docs/press-releases/2009/OMVC-Mobile-TVStudy-December-2009.pdf.

c. Provide certainty to TV viewers and broadcasters by limiting the FCC's authority to hold only one incentive auction of television spectrum

To minimize disruptions to viewers and to provide some economic certainty to the broadcast industry, Congress should allow the FCC to hold only one incentive auction of broadcast spectrum. Multiple auctions could severely undermine broadcasters' ability to attract capital for long-term investment, and could result in continuing disruption for viewers if stations are moved multiple times. Stability is also important to promote further innovation. Long-term planning requires that broadcasters and high tech companies that invest and build broadcast technology have confidence in the future of the industry and, specifically, that TV broadcasters will have interference-free spectrum to provide new services to their viewers. The threat of multiple auctions will undermine that confidence, and in turn, limit innovations in the broadcast band.

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[25] As of the end of 2010, television stations were offering 142 Spanish-language network-affiliated multicast channels. *See* Justin Nielson, "TV Stations Multiplatform Analysis '11 Update: Multicasting Expands Programming Options, Mobile DTV Goes Live," *Broadcast Investor* (SNL Kagan) (Jan. 27, 2011). And broadcasters are continuing to roll out new services, such as Bounce TV, a new multicast network aimed at serving African-American audiences.

d. Hold harmless and make whole those broadcasters that choose not to volunteer for the auction but who must bear the substantial cost of relocating to a new channel

Congress should consider the economic impact of any potential reallocation on stations that do not participate. The FCC has indicated it will "repack" broadcast stations after an incentive auction. While an incentive auction may be a voluntary process, re-packing is not. This means that some stations will be forced to move to new channel locations just two short years after expending millions of dollars to convert to all-digital broadcasting. Another relocation would be very expensive for some stations, requiring the purchase of new transmitters and other equipment, and could result in the temporary loss of service to consumers. Auction revenues should be used, in part, to cover those costs. Compensating licensees disrupted by relocation is consistent with past FCC practice.

If broadcasters that choose not to participate in a voluntary auction are forced to pay for relocation to new channels – costs that could be higher than $4 million for some stations[26] – viewers will suffer from reduced investment in broadcast programming and services, including local news and weather. This result is not in the public interest.

IV. Conclusion

As always, I appreciate the opportunity to speak before this Subcommittee and provide broadcasters' views on an issue that is critical to the future of American telecommunications. A potential spectrum auction is one of the most significant issues that has faced television broadcasters in the history of the service. As you can imagine, many broadcasters fear what this could mean for their business and for the industry. Perhaps more important is the voice we are not hearing from today – the millions of viewers that rely on local television for their news, information, emergency alerts and more. I respectfully ask that this Subcommittee consider how any incentive auction will affect them. As we learned from the DTV transition, if we do not get this right, and viewers lose access to local television stations, you can be sure that group will not remain silent for long.

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[26] *See* Testimony of Robert Good, Assistant General Manager, Director of Operations, and Chief Engineer, WGAL-TV, Lancaster, PA, Before the House Energy and Commerce Committee, Subcommittee on Communications and Technology at 10 (Apr. 12, 2011).

I look forward to answering any questions you may have.

Thank you.

NATIONAL ALLIANCE OF
STATE BROADCASTERS
ASSOCIATIONS

Alabama Broadcasters Association
Alaska Broadcasters Association
Arizona Broadcasters Association
Arkansas Broadcasters Association
California Broadcasters Association
Colorado Broadcasters Association
Connecticut Broadcasters Association
Florida Association of Broadcasters
Georgia Association of Broadcasters
Hawaii Association of Broadcasters
Idaho State Broadcasters Association
Illinois Broadcasters Association
Indiana Broadcasters Association
Iowa Broadcasters Association
Kansas Association of Broadcasters
Kentucky Broadcasters Association
Louisiana Association of Broadcasters
Maine Association of Broadcasters
Massachusetts Broadcasters Association
Maryland, DC, Delaware Broadcasters
Michigan Association of Broadcasters
Minnesota Broadcasters Association
Mississippi Association of Broadcasters
Missouri Broadcasters Association
Montana Broadcasters Association
Nebraska Broadcasters Association
Nevada Broadcasters Association
New Hampshire Association of Broadcasters
New Hampshire Broadcasters Association
New Jersey Broadcasters Association
New Mexico Broadcasters Association
The New York State Broadcasters Association
North Carolina Association of Broadcasters
North Dakota Broadcasters Association
Ohio Association of Broadcasters
Oklahoma Association of Broadcasters
Oregon Association of Broadcasters
Pennsylvania Broadcasters Association
Puerto Rico Broadcasters Association
Rhode Island Broadcasters Association
South Carolina Broadcasters Association
South Dakota Broadcasters Association
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Wyoming Association of Broadcasters

July 13, 2011

The Honorable John Boehner
Speaker
United States House of
Representatives
H-232 Capitol Building
Washington, DC 20515

The Honorable Nancy Pelosi
Minority Leader
United States House of
Representatives
H-204 Capitol Building
Washington, DC 20515

Dear Speaker Boehner and Minority Leader Pelosi:

As Congress works to craft comprehensive spectrum policy, we write to express the views of America's local broadcasters. We support efforts to improve broadband service and provide our nation's first responders with state-of-the-art communications. In doing so, it is important that Congress protect the interests of television viewers and the services free local TV stations provide.

As our nation's original wireless communications service, local television stations work hand-in-hand with our nation's first responders in times of emergency. Through this partnership, we understand the need for an interoperable public safety network, in addition to a robust free broadcast system. As shown by the recent natural disasters across the country, local broadcasters are not only irreplaceable as the first alert of incoming danger, they are also integral in the rebuilding of communities. Local broadcasters take seriously their obligations as stewards of the nation's public airwaves.

Local television broadcasters do not oppose truly voluntary incentive auctions that allow for a continued robust free broadcasting system. However, our concerns are directed at the "repacking" of local television stations at the conclusion of incentive auctions, and the need for viewer protections that will preserve the ability of all Americans to continue to receive a robust, free over-the-air television signal.

Those protections should include the following:

(1) The Federal Communications Commission (FCC) should be required to replicate each remaining station's coverage area so that no viewers are disenfranchised. Even if stations are assigned new channels, every remaining station should be permitted to broadcast in the same manner they do today. They should not be reassigned to channels that consumers have difficulty receiving. Additionally,

stations should be able to rely on the same interference rules that are in place today. A reduction in these protections will ultimately disenfranchise viewers. For example, consumers in urban areas will find it difficult to receive their favorite TV stations with indoor antennas, and it will also be more difficult to receive signals in rural areas, which are typically at the outer fringes of a television station's coverage area.

(2) Television broadcasters should be able to continue to innovate with new offerings, such as digital mobile television, by preventing the FCC from involuntarily moving television stations from the UHF band to the VHF band where new services cannot be offered. Encouraging television broadcaster innovation will help to maintain a healthy and competitive video landscape.

(3) The FCC should be limited to holding a single incentive auction for television spectrum, and minimize the impact of repacking on the remaining television stations, so that viewers are not continually subjected to the confusion that results from stations shifting from one channel to another.

(4) Television broadcasters spent over $15 billion to comply with the government mandate to convert from analog to digital television. If the government is now going to rearrange the television broadcast bands again, it is essential for sound spectrum policy to address the economic impact of relocation on television broadcasters.

A recent study has found that nearly 46 million viewers rely exclusively on over-the-air broadcasts for their television service, and most cable systems rely on an over-the-air signal to retransmit to their subscribers. It is vital that the coverage patterns and technical integrity of television transmissions be protected.

Importantly, we need to ensure stability for viewers on a going-forward basis. Two years ago our country completed its transition to digital television in which every television station shut off its analog transmitter and broadcast only in a digital format, typically on a different channel. The result was a considerable amount of confusion for television viewers. Even today, there continue to be viewers who cannot receive a signal from a station they previously viewed without difficulty. The repacking provisions currently pending in Senate legislation offer a similar, and perhaps more complex, transition, which we anticipate will cause confusion and possible disruption for many television viewers.

The American system of television broadcasting is unique in all the world. Our viewers rely on the ubiquitous availability of free, over-the-air television. We urge you to help us remedy these remaining concerns before legislation is considered, either through traditional procedures or in debt ceiling negotiations. It is imperative that the television stations we represent retain the flexibility to continue to innovate as technologies and markets evolve.

Sincerely,

America's Independent State Broadcasters Associations

Alabama Broadcasters Association
Sharon Tinsley

Darlene Simono

Alaska Broadcasters Association
Darlene Simono

Arizona Broadcasters Association
Art Brooks

Arkansas Broadcasters Association
Doug Krile

California Broadcasters Association
Stan Statham

Colorado Broadcasters Association
Byron Grandy

Michael C. Rice

Connecticut Broadcasters Association
Mike Rice

Florida Association of Broadcasters
Pat Roberts

Georgia Association of Broadcasters
Jere Pigue

Jamie Hartnett

Hawaii Association of Broadcasters
Jamie Hartnett

Idaho State Broadcasters Association
Connie Searles

Illinois Broadcasters Association
Dennis Lyle

Linda C. Compton

Indiana Broadcasters Association
Linda Compton

Iowa Broadcasters Association
Sue Toma

Kansas Association of Broadcasters
Kent Cornish

Gary R. White

Kentucky Broadcasters Association
Gary White

Louisiana Association of Broadcasters
Lou Munson

Maine Association of Broadcasters
Suzanne Goucher

Maryland/D.C./Delaware (MDCD) Broadcasters Association
Lisa Reynolds

Jordan Walton

Massachusetts Broadcasters Association
Jordan Walton

Karole L White

Michigan Association of Broadcasters
Karole L. White

Jim du Bois

Minnesota Broadcasters Association
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Mississippi Association of Broadcasters
Jackie Lett

Missouri Broadcasters Association
Donald Hicks

Montana Broadcasters Association
Greg MacDonald

Nebraska Broadcasters Association
Marty Riemenschneider

Nevada Broadcasters Association
Robert Fisher

Jordan Walton

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Pennsylvania Association of Broadcasters
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Radio Broadcasters Association of Puerto Rico
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Shani White

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South Carolina Broadcasters Association
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SOUTH DAKOTA BROADCASTERS ASSOCIATION

South Dakota Broadcasters Association
Steve Willard

Whit Adamson

TENNESSEE SINCE 1948 ASSOCIATION OF BROADCASTERS

Tennessee Association of Broadcasters
Whit Adamson

Ann Arnold

TAB

Texas Association of Broadcasters
Ann Arnold

UBA

Utah Broadcasters Association
Dale Zabriskie

Jim Condon

VAB
Vermont Association of Broadcasters

Vermont Association of Broadcasters
Jim Condon

VAB
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Touching more lives.

Virginia Association of Broadcasters
Doug Easter

Mark Allen

WSAB

Washington State Association of Broadcasters
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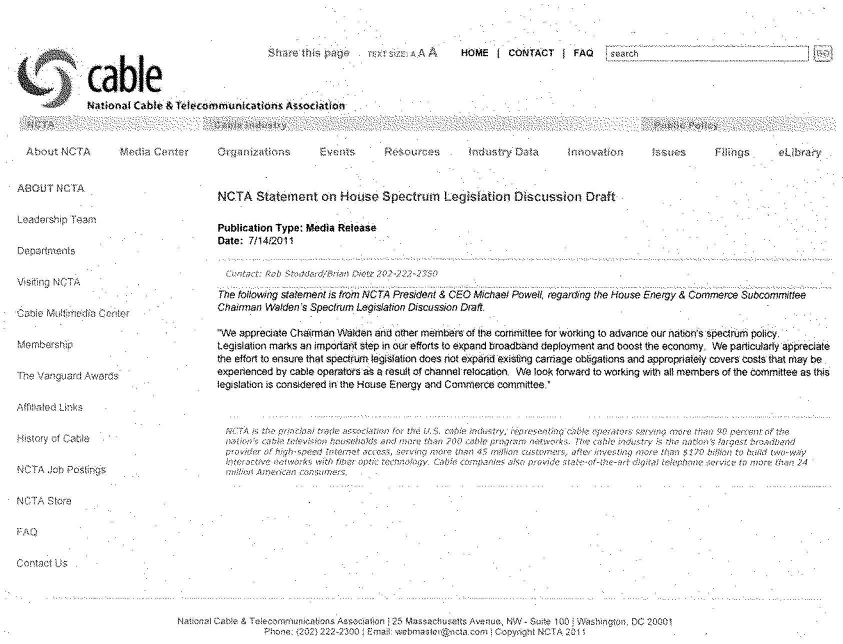

NCTA Statement on House Spectrum Legislation Discussion Draft

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Contact: Rob Stoddard/Brian Dietz 202-222-2350

The following statement is from NCTA President & CEO Michael Powell, regarding the House Energy & Commerce Subcommittee Chairman Walden's Spectrum Legislation Discussion Draft.

"We appreciate Chairman Walden and other members of the committee for working to advance our nation's spectrum policy. Legislation marks an important step in our efforts to expand broadband deployment and boost the economy. We particularly appreciate the effort to ensure that spectrum legislation does not expand existing carriage obligations and appropriately covers costs that may be experienced by cable operators as a result of channel relocation. We look forward to working with all members of the committee as this legislation is considered in the House Energy and Commerce committee."

NCTA is the principal trade association for the U.S. cable industry, representing cable operators serving more than 90 percent of the nation's cable television households and more than 200 cable program networks. The cable industry is the nation's largest broadband provider of high-speed Internet access, serving more than 45 million customers, after investing more than $170 billion to build two-way interactive networks with fiber optic technology. Cable companies also provide state-of-the-art digital telephone service to more than 24 million American consumers.

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Mr. WALDEN. We turn now to Mr. Christopher Guttman-McCabe—sorry. Oh, I guess I did. We will turn now to Mr. Michael Calabrese, senior research fellow, Open Technology Initiative, of the New America Foundation. We welcome your comments here, sir. And please go ahead.

STATEMENT OF MICHAEL A. CALABRESE

Mr. CALABRESE. Good morning, Chairman Walden, Ranking Member Eshoo, and members of the subcommittee. My name is Michael Calabrese, director of the Wireless Future Project at the New America Foundation's Open Technology Initiative here in Washington. I am testifying on behalf of the Wireless Innovation Alliance, a coalition of both large and startup high-tech firms, rural, wireless ISPs, and consumer and public interest groups.

Most of the debate about incentive auction authority, as we have heard today, has focused on protecting local broadcasters, promoting public safety and auctioning licenses to wireless carriers. But another critical public interest should be safeguarded as well, unlicensed use of the TV white space channels.

It is essential that any incentive auction authority give the FCC the ability and obligation to preserve substantial access to unlicensed spectrum in every local TV market. Under the FCC order adopted unanimously in 2008, after years of study, WiFi-type devices are allowed to operate on an unlicensed basis on unused DTV channels, provided that the devices have GPS and periodically check an online database to find out what channels can be used without risking interference with DTV reception.

Investment and trial deployments of a wide range of innovative devices and services is well under way. My testimony describes a half dozen successful white space trials; for example, a smart city deployment in Wilmington, North Carolina; a smart grid deployment in California's Sierra Mountains; a rural broadband deployment in Claudville, Virginia; a public safety and tribal lands deployment in northern California, and so on.

While the voluntary incentive auctions in the discussion draft strike a reasonable balance, we have very serious concerns with section 104, which for the first time would require auctions for unlicensed spectrum. Under section 104, the FCC could make spectrum available for unlicensed use only through an auction where the highest bidders, rather than the expert agency, determine whether the service rules for a particular band in a particular area will be exclusively licensed or unlicensed.

Requiring auctions for unlicensed spectrum is unstudied, untested, unworkable and virtually certain to ensure that no new unlicensed spectrum is actually allocated. It will effectively preclude the FCC from repacking the TV band in a manner that maintains access to unlicensed channels for super-WiFi services that industry is in the process of deploying.

If this provision had been in place before WiFi and before the FCC designated the 2.4 gigahertz band for unlicensed use, America's invention of today's multibillion-dollar WiFi industry would never have occurred. If this bill had been law then, today there would not be more than 2,000 wireless ISPs using unlicensed spectrum to bring broadband Internet service to 2 million Americans living in rural, remote and small-town areas. If this bill had been law, today consumers would not be saving roughly $15 billion per year because WiFi allows multiple users at home and work to share a single wired line. WiFi would not be offloading 20 to 30 percent of the mobile data traffic from smart phones and tablets, helping to ease the spectrum crunch. AT&T Wireless would not have 24,000 WiFi hotspots to help its customers get faster and free broadband access in public places. The three largest cable companies would not have combined to blanket New York City with WiFi; and universities, hospitals, libraries and other public spaces would not be hotspots, helping millions get Internet access cheaply, easily and without wires.

The auction model mandated in the draft bill is also unworkable and seems more likely to decrease Federal revenue than to increase it. Putting service rules up for auction creates tremendous uncertainty about how much of a band will end up licensed or unlicensed. This undermines the revenue-raising potential of the auctions and could lower the score that CBO could put on what would be an unpredictably contingent set of auctions.

Unlicensed spectrum is something fundamentally different from licensed. A license gives a company exclusive use at high power and protection from interference. Unlicensed bands are open to anyone at very low power, with no protection from interference.

Even the FCC economists who outlined the draft's proposed mechanism 3 years ago identified a series of problems that make this idea unworkable in the real world. The primary one is the free rider problem. Because unlicensed spectrum is a public good available to anyone, even the largest companies that rely on unlicensed have an incentive to hold back and let others pay the government. These noncarrier firms say they would not even bid. They are not in that business. They are only indirect beneficiaries, just as trucking companies are with respect to interstate highways.

To conclude, I will just say that the U.S. economy and consumers will continue to benefit most from a balanced and complementary mix of licensed and unlicensed spectrum. Unlicensed technologies pioneered here in America are increasingly so complementary and critical to the wireless ecosystem that Congress can best optimize the TV band spectrum for broadband, for job creation and innovation by ensuring continued unlicensed access to substantial amounts of TV white space spectrum in every local market and nationwide.

Thank you.

Mr. WALDEN. Thank you for your comments.

[The prepared statement of Mr. Calabrese follows:]

Testimony of

Michael Calabrese
Director, Wireless Future Project
Open Technology Initiative
New America Foundation

On behalf of the
Wireless Innovation Alliance and
Public Interest Spectrum Coalition

"Legislative Hearing to Address Spectrum and Public Safety Issues"

Before the

Committee on Energy and Commerce
Subcommittee on Communications and Technology
United States House of Representatives

July 15, 2011

Testimony of
Michael Calabrese
Director, Wireless Future Project, New America Foundation
On behalf of the
Public Interest Spectrum Coalition

Before the
Committee on Energy and Commerce
Subcommittee on Communications and Technology
United States House of Representatives

July 15, 2011

Thank you, Chairman Walden, Ranking Member Eshoo and members of the Committee, for this opportunity to testify today on the critical issue of how best to reallocate the nation's public spectrum resource to promote mobile broadband, while promoting public safety communication and preserving the public benefits of over-the-air broadcasting.

My name is Michael Calabrese, Director of the Wireless Future Project at the New America Foundation's Open Technology Initiative. New America is a nonpartisan public policy institute based here in Washington, DC. On issues concerning spectrum and wireless broadband policy, New America is part of the Public Interest Spectrum Coalition (PISC), which represents national consumer and advocacy groups including Consumers Union, Consumer Federation of America, Free Press, Public Knowledge and other nonprofits. New America is also a member of the broader Wireless Innovation Alliance (WIA), which includes most of PISC as well as high-tech companies both large (e.g., Dell, Microsoft, Google) and small (e.g., Shared Spectrum, Adaptrum).

My testimony will focus on the importance of designing TV band incentive auctions in a way that preserves the current access to unlicensed spectrum (the co-called "TV White Spaces") in every local market and nationwide for "Super WiFi" and other new technologies and services. At the end I also comment on the Spectrum Relocation Improvement Act of 2009, H.S. 3019. I will make the following main points:

- The voluntary incentive auctions described in the Discussion Draft appear to strike a reasonable balance with respect to reallocating and repacking broadcast station licensees in order to reassign a portion of the band to meet the surging demand for wireless broadband services.
- While local broadcasting should be protected, it is likewise essential that any incentive auction authority also give the FCC the ability and obligation to preserve substantial access to unlicensed spectrum in every local TV market.
- We have serious concerns with the Draft's provision (Section 104) requiring that the "Allocation of Spectrum for Unlicensed Use" must be done only subject to competitive bidding through a system where the highest bidders – rather than the expert agency – determine whether the service rules for a particular band in a particular area will be exclusively licensed or unlicensed.
- This provision, requiring auctions for unlicensed spectrum, is unstudied, untested, unworkable, and virtually certain to ensure that no new unlicensed spectrum is actually allocated.
- It will effectively preclude the FCC from repacking the TV band in a manner that maintains access in every market to the unlicensed TV White Space channels, the "Super Wi-Fi" service that industry is in the process of deploying after unanimous approval by both a Republican-led and a Democrat-led FCC.
- The FCC economists who hypothesized the Draft's proposed auction mechanism for unlicensed spectrum also made it clear why problems with "free riders," bid aggregation, collusion and the need for spectrum caps and other eligibility limitations likely make this idea unworkable in the real world.
- Putting service rules up for auction creates tremendous uncertainty about how much of a band will end up licensed or unlicensed, undermining the revenue-raising potential of the auctions to a degree that will undoubtedly lower the score that CBO can put on what would be an unpredictably contingent auction.
- Unlicensed technologies, pioneered in America, are increasingly so complementary and critical to the mobile broadband ecosystem that Congress can best optimize TV band spectrum for broadband deployment, job creation and

economic growth by ensuring continued unlicensed access to substantial amounts of TV White Space spectrum in every local market and nationwide.

- Concerning H.R. 3019, many Federal bands are particularly well-suited for increased sharing with the private sector, but this will require not just streamlining the CSEA's Spectrum Relocation Fund process but also broadening eligibility so that agencies have the resources to upgrade systems to share capacity on a far greater number of bands.

Introduction

While most of the debate concerning incentive auction authority and a repacking of TV band spectrum has focused on protecting local broadcasters and auctioning licenses to wireless carriers, another critical public interest in the TV bands need to be safeguarded as well: unlicensed use of TV White Space channels. At present the majority of TV channels in each of the nation's 210 media markets is not used for TV broadcasting, but has been reallocated by the Federal Communication Commission for unlicensed use. Under the Report & Order adopted unanimously by the Commission in November 2008,[1] both fixed and mobile broadband devices will be allowed to operate on an unlicensed basis on unused DTV channels ("white space") provided that the devices have GPS and the capability to periodically check an online database of available TV channel frequencies in that discrete geographic location. TV band white space devices are required to query one of nine competing databases, operated by private companies, already approved by the FCC to determine available channels at their current location before transmit capabilities are engaged.

The initial proposal to open the White Space channels for unlicensed use was put forward FCC Chairman Michael Powell, who remains a supporter today. When the proceeding stalled at the FCC, bipartisan legislation introduced by senior Republicans and Democrats on the House and Senate Commerce Committees would have required the FCC to complete the reallocation within six months, prompting the FCC to adopt an Order in November, 2008. After nearly eight years of study and debate, last September a unanimous Commission voted 5-0 for a second time to give final approval to unlicensed use of the unassigned TV channels in all 210 local TV markets, facilitating new wireless technologies that have been dubbed "Super Wi-Fi." As described further below, investment and trial deployments of a wide range of innovative devices and services is already well underway on this new unlicensed band. The U.S. invented Wi-Fi and leads the world in unlicensed technologies, already a multi-billion industry. We believe it is essential that any incentive auction authority also give the FCC the ability and obligation to preserve substantial access to unlicensed spectrum in every local TV market.

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[1] Unlicensed Operation in the TV Broadcast Bands, *Second Report and Order and Memorandum Opinion and Order*, ET Docket No. 04-186, ET Docket No. 02-380, FCC 08-260 (released November 14, 2008) ("*TVWS Order*").

Discussion Draft: The Spectrum Innovation Act of 2011

The voluntary incentive auctions described in the Discussion Draft appear to strike a reasonable balance with respect to reallocating and repacking broadcast station licensees to reassign a portion of the band for *licensed* use on an exclusive basis. However, we have serious concerns with the Draft's provision requiring that the "Allocation of Spectrum for Unlicensed Use" must be subject to competitive bidding. Section 104 (pp. 25-27) provides that unlicensed spectrum be assigned only by auction in an untested manner that is unworkable for a variety of reasons. This provision is virtually certain to ensure that no new unlicensed spectrum is actually allocated. It will effectively preclude the FCC from repacking the TV band in a manner that maintains access in every market to the unlicensed TV White Space channels, the "Super Wi-Fi" service that industry is preparing to deploy after unanimous approval by both a Republican-led and a Democrat-led FCC. Indeed, had this provision been in place before the FCC designated the 2.4 GHz band for unlicensed sharing, America's invention of today's multi-billion dollar Wi-Fi industry, with all its benefits, would never have occurred.

Section 104: Auctioning Unlicensed Spectrum

The temptation to try to raise some additional federal revenue by auctioning not only licenses for exclusive use of public spectrum, but also the spectrum bands set aside for *unlicensed* use is understandable. After all, spectrum is a valuable public resource, whether it's assigned for exclusive use by a single company (licensing) or for open access by any individual, company, entrepreneur or institution that abides by the low power limits and other "rules of the road" governing its use. The reality is that auctioning "unlicensed" spectrum – such as the Wi-Fi band (at 2.4 GHz) or the new Super Wi-Fi spectrum (TV White Spaces) – is impractical as a revenue raiser *and* could even reduce the net revenue from auctions for exclusive licenses by creating enormous uncertainty about whether a band of frequencies would end up a patch quilt of licensed and unlicensed, subject to different technical rules and with no ability to later create a nationwide or possibly even a regional service. It would also undermine the nation's longer term economic interest in ensuring opportunistic use of wireless broadband and the emergence of increasingly interconnected "smart" radio devices.

There is no practical way to auction 'unlicensed' spectrum while preserving the unique benefits of enabling anyone to use the band. The U.S. economy and society would continue to benefit most from a balanced and complementary mix of licensed *and* unlicensed – with access to both in frequency ranges with diverse propagation characteristics. Further below I describe some of these unique and proven benefits, which include the efficient offload of at least 20% of carrier mobile data traffic, rural and remote broadband by thousands of small WISPs and RLECs, the ability of tens of millions of homes and businesses to wirelessly share a single wired Internet connection, and tremendous innovation that would not occur in a licensed-only world. The TV White Spaces represent the last opportunity to obtain unlicensed spectrum below 1 GHz and without it many user scenarios will not emerge for the foreseeable future.

Putting aside the unique benefits of unlicensed spectrum, nobody has come up with a practical way to auction unlicensed spectrum. The Discussion Draft requires the FCC to auction the option to designate a band for unlicensed use – an unprecedented, unstudied auction concept described in a single 2008 paper by two FCC staff economists.[2] The staff economists hypothesized a new type of "clock auction," where both carriers and a broad range of other companies could bid for spectrum at auction, specifying whether they wanted the band for licensed or unlicensed use. The high bid for each block would determine how much spectrum in the auction would be licensed or unlicensed. The FCC economists explained that, in theory, this should reveal the value that various firms attach to access to licensed versus unlicensed spectrum. However, they go on to identify the following challenges and fatal flaws with this approach in the real world:

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[2] Bykowsky, M., Sharkey, W., and Olson, M., "A Market-based Approach to Establishing Licensing Rules: licensed Versus Unlicensed Use of spectrum," FCC, OSP Working Paper Series, No. 43 (2008). Bykowsky and Sharkey are FCC staff economists; Olson is a professor at George Mason University. OSP working papers do not necessarily reflect FCC policy.

Free Rider Problem: Because unlicensed spectrum is a "public good" available to anyone, even the largest among the many thousands of companies and nonprofit institutions that rely on unlicensed have an incentive to hold back and let others pay the government. As the FCC economists explain, "although it is in every ... firm's interest to have spectrum designated to unlicensed use, any individual [] firm has an incentive to'free ride' off the bids of other bidders in an attempt to maximize their own profits."[3] Winning bidders must shoulder the cost of a common resource that benefits not only competitors, but many thousands of other firms, tens of millions of households and the entire economy. The FCC economists analogize this to a fundraising telethon – but unlike a charitable cause, it seems unlikely that for-profit companies that can internalize only a small fraction of the value of unlicensed operations will agree to subsidize other users. And although the economists suggest that coordination ("collusion") among bidders might get over this, they conclude the paper by warning that "[i]f a significant number of [users] that wish to see spectrum designated to unlicensed operations free ride on the bids made by other[s] ... then the efficient designation of spectrum to licensed and unlicensed operations may not occur."

Collective Action Problem – Aggregating Bids: Another challenge identified by the FCC economists is that "the value that society obtains from ... unlicensed operations, given their unfettered open access nature, is equal to the summation of the valuations that [users] place on having such a designation."[4] Incumbent carriers would always outbid even large firms and institutions that use unlicensed, unless the users can coordinate and aggregate their bids. The Discussion Draft anticipates this, providing that a band in a geographical area would be unlicensed if "the bids for unlicensed use, in the aggregate, exceed the highest bid for such license." However, this presents a *collective action problem*: how do you aggregate the bids for unlicensed spectrum? Bidders potentially include thousands of high-tech companies and device manufacturers, tens of thousands of other firms (e.g., hotel and retail chains, hospitals, schools), and tens of millions of employers and households whose bids should be aggregated since they benefit most (in aggregate) from unregulated access. Most unlicensed operators, such as the nation's 2,500 small business WISPs, will be unable to raise the capital to bid on shared, non-exclusive use.

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[3] *Ibid* at p. 15.
[4] *Id.* at p. 7.

The Draft also leaves critical implementation issues unanswered. Must bids be proportionate to future use? Will be FCC register, convene and coordinate what could be thousands of bidders with extremely diverse use cases in mind? If not, who will? There will also be companies that decide to deliver products and services years after the allocation and that would not participate in the auction.

Auctioning Unlicensed Requires Collusion and thus Exclusion: Because of the first two challenges, the FCC economists conclude that non-carriers must be allowed to collude in their bidding strategies.[5] Although a small number of companies and/or carriers could collude – forming a consortium to bid – they could only profit by limiting use of the spectrum to their own customers. For example, if Verizon were to combine with Google to 'own' unlicensed spectrum, they could (and rationally would) exclude customers of other carriers and Internet companies. The spectrum would then be *licensed* – and millions of other firms and individuals would be excluded in a way they are not from *unlicensed* bands. Since much of the most valuable wireless innovation has come from start-ups and small companies on the unlicensed bands. Moreover, this hypothesized collusion is both unrealistic (see below) and, even if the FCC waives the strict anti-collusion rules that applied to every previous auction, possibly violates antitrust laws. The FCC economists' proposal would not permit the winning bidders to exclude others or change the FCC's Part 15 rules. The Discussion Draft is ambivalent on this point, although without the ability to set the rules and exclude others, there would be little profit motive for any firm other than a spectrum speculator who hopes to change the rules later.

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[5] *Id.*

Spectrum Caps and/or Bidding Discounts Required: The FCC economists also observe that an auction of unlicensed may "fail" if wireless carriers (such as Verizon and AT&T) are allowed to participate. "[I]f the value that [carriers] place on spectrum is driven largely by the profits they would earn from not having the spectrum in the hands of a competitor, an auction … to guide the licensing rule determination [between licensed and unlicensed] may not lead to the efficient outcome."[6] As a remedy, the FCC economists propose either "a spectrum cap" or "discounting the [carrier's] bid by an amount equal to the value … [of] owning the asset for purely anticompetitive reasons."[7] Although the Discussion Draft describes the FCC economists' hypothetical auction model, the very next section of the Draft contradicts this essential regulatory precondition. Section 105 of the Discussion Draft adds a paragraph (18)(B) that prohibits the Commission from limiting participation in an auction for licensed or unlicensed spectrum based on "the total amount of spectrum licenses held by a person." While New America and PISC believe that the Commission should retain its authority to promote competition by imposing "spectrum caps" or other limits on allocations and auctions where appropriate (a policy the FCC successfully employed in the 1990s to ensure at least 5 competing cell phone providers in each market), the Draft's ban has the effect of allowing the largest incumbent carriers to foreclose entry, competition and innovation simply by outbidding the undefined aggregation of future unlicensed users who might be inclined to bid.

The insurmountable problems above, identified in the FCC's own theoretical paper, are minor compared to the policy downsides inherent in this approach. Among our most serious additional concerns are the following:

The auction model will increase uncertainty and reduce government revenue: We believe that putting the service rules up for auction – thereby creating uncertainty about how much of a band will end up licensed or unlicensed – will undermine the revenue-raising potential of the auctions. This will undoubtedly lower the score that CBO can put on what would be unpredictably contingent auction. CBO could not know in advance what spectrum the FCC will decide to make available for licensed versus unlicensed bidding. The FCC would need to develop dual service rules, since neither the agency nor any bidder would know whether at the end of the auction how much of the spectrum would end up licensed (exclusive, flexible, high-power) or unlicensed (shared, subject to FCC database control, low-power).

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[6] *Id.* at p. 15, note 23.
[7] *Id.*

The Discussion Draft encourages the FCC to auction smaller geographic licenses, which will compound the uncertainty. Since presumably some local areas will end up licensed and some unlicensed, with winners operating under widely varying service rules, these frequency bands could never again be aggregated nationwide or possibly even regionally. And if instead the legislation requires all such spectrum to be auctioned only on a national basis – or even by regional aggregation (as the C Block was in the 700 MHz auction of 2008), then like the C Block the only likely winners of any auction would be the two dominant carriers, leaving their small, rural and regional carriers and WISPs effectively excluded. Since to date every auction has been conducted on the basis of certainty concerning both service rules and the types of services that will be operating in adjacent areas and frequencies, carriers expected to be the highest bidders for this contested spectrum would necessarily need to lower their bids to account for all the various uncertainties introduced by a contested licensed vs. unlicensed auction.

Auctioning unlicensed ignores the biggest beneficiaries of unlicensed: The FCC economist paper refers only to "firms" bidding to decide if a given block of spectrum should be licensed or unlicensed. However, this ignores both the origins of unlicensed spectrum and its primary beneficiaries: which are currently nearly every American home, individual, small business and nonprofit institution. The cumulative benefit to all these homes, businesses and community anchor institutions – for Wi-Fi alone – is in the tens of billions of dollars each year, generating hundreds or thousands of jobs and boosting both Internet use and overall productivity. Before Wi-Fi boomed, the unlicensed Industrial, Scientific and Medical (ISM) bands were called "junk bands" because the FCC had left the band open as a very easy, low-cost way for individual consumers and device makers to market and operate low-power, off-the-shelf items including cordless phones, baby monitors and microwave ovens – all of which are certified under the Commission's Part 15 (unlicensed device) rules. Many hundreds of millions of these devices continue to operate in unlicensed bands, along with a rapidly growing number of machine-to-machine chips that facilitate applications including RFID, remote irrigation control for farmers/ranchers, and remote monitoring of a myriad of industrial, weather and other systems (even some dental office drill bits now send an email when they need to be replaced). Unlicensed access to the TV White Space channels will magnify the utility of all these uses, particularly for rural and industrial (machine-to-machine) uses.

Non-carrier firms say they have no incentive to 'own' unlicensed bands: Even if we assume away the "free rider" and coordination problems noted above, manufacturers, software firms, big-box retailers, universities, hospitals and others that clearly benefit from unlicensed are not in the business of managing and selling wireless ISP subscriptions. No one firm (or even several) could internalize enough profit to cover the cost to outbid carriers, unless they excluded others and charged subscription fees. They do not sell wireless Internet access–it's neither their business nor expertise. They are only indirect beneficiaries – as trucking companies are with respect to interstate highways, or as shipping companies are with respect to the open access to oceans and other waterways.

Spectrum speculators are the most likely purchasers of 'unlicensed' bands: As it has in the past, the FCC seems most likely to auction for potential unlicensed use the bands that are *least* attractive to wireless carriers and other purchasers of exclusive licenses. That is the history of the TV White Spaces (TVWS), for example, which for decades were unoccupied guard band channels that could only be used, if at all, at extremely low power levels to protect television reception (40 milliwatts on a first adjacent channel under the TVWS Order adopted in 2008). Going forward, some of the Federal bands mandated for auction in Section 101 of the Discussion Draft represent bands that either are at high frequencies (5 GHz band) or will be subject to exclusion zones and other restrictions (such as very low power, or preemption by public agencies) that will not fit the business model of commercial networks. Like the TVWS, some of this spectrum may be best suited for unlicensed sharing – and coordinated through a Database and/or by spectrum sensing and other techniques to protect Federal users from interference. Since the Discussion Draft requires that all shared access bands are to be auctioned, they will be acquired by someone – most likely by spectrum speculators who will plan to warehouse them until a lobbying strategy can free them from some of these constraints.

An example is the Federal band frequencies between 5350-5470 and 5850-5925. It's extremely doubtful that the Defense radar, air telemetry and other Federal systems on these bands will be discarded or relocated. Yet unlike the bipartisan Senate bill, S. 911, which directs the NTIA and FCC to take steps to share these frequencies on a limited basis with low-power unlicensed devices (as other radar systems on other portions of the 5 GHz band already do), the Discussion Draft requires that whatever capacity the Administration decides to share will be auctioned. That will raise little revenue, but could easily sideline this spectrum from highly-productive shared use at low power. While this 5 GHz spectrum has very limited utility compared to the unlicensed TV "white space" spectrum (for example, it's not useful for mobile applications), it would be far better to give the expert agency the authority to decide, based on trends in technology and other considerations, whether the shared usage rights should be auctioned for license, unlicensed, or perhaps subject to some other arrangement, such as micro-payment leasing on secondary markets, or by the FCC itself using the TV Band Database administrators.

A mandatory database for unlicensed use will impose unnecessary costs: The Discussion Draft requires the FCC to "establish and maintain a database to coordinate the unlicensed use" of portions of the spectrum designated unlicensed by competitive bidding. The Draft does not state whether the purpose of this database is to coordinate the exclusive use of the "unlicensed" band by the winning bidders, in order to exclude others; or whether, like the geolocation database providers recently selected by the FCC to govern access to unlicensed TV White Space spectrum, the purpose is to promote greater spectrum efficiency and minimize interference among anyone choosing to use the band. While a database approach to governing spectrum sharing is the wave of the future – and can be very beneficial when needed to avoid interference, which is the rationale behind TV Bands Database – the generic database mandate proposed here will impose substantial and unnecessary costs on industry and on consumers. For example, the cost of RFID tags and unlicensed chips in a huge range of low-cost consumer devices (e.g., toys, wireless picture frames) would become far more expensive if they needed the ability to contact and coordinate with an FCC database, presumably reporting their location (via GPS), before they could transmit.

In sum, we strongly urge the members of the Subcommittee to drop this untried and unworkable section from the bill. An alternative is the approach taken in the bipartisan Senate bill already reported out of Committee, S. 911, which leaves the FCC with discretion to reorganize the TV band to auction cleared channels for licensed use, while optimizing the remainder of the band's continued use for local broadcasting and for unlicensed "Super Wi-Fi" in the white space channels. S. 911 emphasizes auctions, but it also directs the FCC to "ensur[e] that unlicensed spectrum remains available in these frequency bands, nationwide, and in each local market." This is essentially the same substance as the bipartisan voluntary incentive auction legislation introduced last year by the ranking members of this Subcommittee at that time, Mr. Stearns and Mr. Boucher. We believe this approach – which optimizes use of the TV band for broadcasting and for both licensed *and unlicensed* broadband will generate the greatest gains for the economy in the long-term, while also raising as much or more revenue for the government from auctions in the short term.

Unlicensed Spectrum is Critical to Ubiquitous, Fast, Affordable Mobile Broadband

In addition to incentive auctions for exclusively-licensed spectrum, the Subcommittee can best optimize TV band spectrum for broadband deployment, job creation and economic growth by ensuring that unlicensed access to substantial amounts of TV White Space spectrum will continue to be available in every local market and nationwide. There is no doubt that consumer demand for mobile data applications is exploding worldwide. A national goal of not merely affordable broadband access, but of truly pervasive connectivity – seamless mobile connectivity anywhere and anytime – will require an enormous increase in available spectrum capacity.

Although we focus on mushrooming personal applications such as mobile video, wireless machine-to-machine communication – such as energy monitoring, environmental monitoring and controls, mobile health care monitoring, industrial automation – is also rising rapidly as costs decline. Ericsson has estimated there will be 50 billion connected devices by 2020, leading increasingly to what some already call an "Internet of Things."[8] Unlicensed spectrum as a public resource serves as an incubator of wireless innovation. Far more devices have been certified to use the 2.4 GHz unlicensed band (20,339 by one recent count) than in any other band (the FM band is second with 7,275 devices certified). From wireless local area networks (WLAN) to metro area Wi-Fi networks, Wi-Fi chips have ended up in everything from smartphones and laptops, to portable media players, TVs and cameras,[9] and even bathroom scales.[10] From 2005 to 2008, nearly 1 billion Wi-Fi chipsets were sold.[11] By 2010, Wi-Fi shipments grew to 761 million products – a 29 percent increase from 2009.[12] This growth is likely to continue, with sales likely to exceed 1.5 billion devices a year by 2014.[13] Unleashing an abundance of spectrum and driving down its cost as an input for all things mobile is therefore the single best means by which Congress, the Administration and the FCC can promote innovation and consumer welfare in wireless.

A policy that attempts to meet this surging demand by relying *solely* on clearing and auctioning exclusive licenses that fit the current business model of commercial wireless carriers would be shortsighted and sacrifice future U.S. innovation and competitiveness. Despite the overall abundance of unused spectrum capacity,[14] even in major cities, there is a looming limit to the number of frequency bands below 3 GHz that can be reallocated, by auction or otherwise, to exclusively licensed use. This is evident in the National Broadband Plan's recommendation that an additional 500 MHz of spectrum be allocated for mobile broadband. CTIA, the wireless industry association, told the FCC two years ago that carriers will need at least 800 MHz over the next decade. The FCC's National Broadband Plan identified only 270 MHz in non-Federal bands below 3.7 GHz that might possibly be reallocated for auction – and three-quarters of that amount (210 MHz) is in two bands: TV broadcasting (120 MHz) and Mobile Satellite Services (90 MHz). The remaining 230 MHz would presumably come from Federal bands, even though the Administration has subsequently concluded that few Federal bands can be cleared entirely and will be available primarily for shared use or subject to huge exclusion zones.

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[8] Hans Vestberg, President and CEO, Ericsson, Address to Shareholders, April 13, 2010, available at http://www.ericsson.com/thecompany/press/releases/2010/04/1403231.

[9] Richard Thanki, *The Economic Value Generated by Current and Future Allocations of Unlicensed Spectrum* (Sept. 2009), at p. 19; http://fjallfoss.fcc.gov/ecfs/document/view?id=7020039036.

[10] http://nexus404.com/Blog/2009/07/28/withings-wiscale-wi-fi-bathroom-scale-monitor-your-weight-loss-and-body-fat-using-iphone-app/

[11] Represent an estimate based on Wi-Fi chipsets sales reported by Wi-Fi Alliance.

[12] Wi-Fi Alliance, "Wi-Fi® expands as the center of leading-edge technologies in 2011," Press Release, Jan. 6, 2011; available at http://www.wi-fi.org/news_articles.php?f=media_news&news_id=1035.

[13] Thanki, *supra note* 9, at p. 18.

[14] Actual spectrum measurement studies have demonstrated that even in the most valuable "beachfront" frequencies below 3 GHz, the vast majority of frequency bands are not being used in most locations and at most times. Spectrum measurement studies by the New America Foundation, by Shared Spectrum Company, the Illinois Institute of Technology and others show that even in Manhattan and in Washington

Based on recent NTIA studies and briefings I've received as a member of the Commerce Spectrum Management Advisory Committee (CSMAC), it is clear that a large share of the Federal bands specified in Section 101 of the Discussion Draft (p. 8) will be available only on at best a shared or conditional basis (such as large exclusion zones and/or power limits) that will make it a poor fit with commercial carrier business models, which are premised on high-power and exclusive use. As a result, while the traditional carrier business model will demand more and more exclusive-use spectrum in the short-run to meet surging mobile data demand, it should be equally clear that this model is not sustainable longer term. Meeting consumer demand for mobile data will require some combination of four strategies:

- Increased spectrum access
- Frequency re-use (smaller cell sizes)
- More efficient wireless technologies
- More effective use of wired backhaul (e.g., fiber to the tower)

Martin Cooper, leader of the team at Motorola that invented the first mobile phone, has calculated that frequency re-use is responsible for roughly 64 times more improvement in

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near the White House, less than 20 percent of the frequency bands below 3 GHz are in use over the course of a business day. Spectrum usage rates are, of course, far lower in suburban and rural areas.

total wireless utilization over the past 45 years than any improvement attributable to making more spectrum available.[15] While the FCC estimates that "mobile data demand is expected to grow between 25 and 50 times current levels within 5 years," the total number of wireless industry cell sites grew only 14% over a recent two-year period.[16] There are practical limits to how close carriers can bring their owned infrastructure (transmitters and backhaul) to the individual consumer. As demand for mobile data increases, the industry's cell site bottleneck is a very real constraint and cost that limits the spectrum efficiency of the dwindling number of prime frequency bands that can be auctioned for exclusive use.

In contrast, one of the many proven benefits of unlicensed spectrum is that it facilitates and encourages spectrum frequency re-use over very small areas (a home, business, or school). The most obvious benefit of unlicensed spectrum has been Wi-Fi networks that permit many different users – in a home, at work, in a coffee shop or other "hot spot" – to share the same wired Internet connection. Because Wi-Fi operates at very low power and is open to all users, there can be a many homes, employees or customers of a retail establishment sharing the same 2.4 GHz band in a relatively small area with little or no interference. Unlicensed Wi-Fi routers, chips and services are a rapidly-growing, multi-billion-dollar industry, but more important for the economy, for education and for other purposes is the tremendous *multiplier effect* that Wi-Fi has on the use and utility of the Internet by making a single wired connection available for shared use on a very low-cost, do-it-yourself basis. This generates enormous consumer welfare. A study by economist Richard Thanki, commissioned by Microsoft, estimated that just three unlicensed applications – Wi-Fi routers in homes, Wi-Fi in hospitals, and RFID tracking inventory in clothing retail stores – together would generate between $16 and $37 billion each year in economic value for the U.S. economy over the next 15 years.[17] The Thanki study also estimated that Wi-Fi has increased the adoption of broadband by anywhere between 4.3 and 9.8 million households by making it more economical.

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[15] Martin Cooper, "Cooper's Law," ArrayComm, *available at* http://www.arraycomm.com/serve.php?page=Cooper

[16] According to CTIA data collected by the Commission, during a two-year period after June 2007, total cell sites increased just 14% (from approximately 210,000 to 246,000). *See* Federal Communications Commission, *Mobile Broadband: The Benefits of Additional Spectrum*, Omnibus Broadband Initiative, Technical Paper No. 6, at pp. 2, 5 (Oct. 2010) ("OBI Paper"), at 12-13, Exh. 8.

[17] *See* Richard Thanki, *The Economic Value Generated by Current and Future Allocations of Unlicensed Spectrum* (Sept. 2009), at p. 19; http://fjallfoss.fcc.gov/ecfs/document/view?id=7020039036.

Because of its efficiency and low cost, unlicensed spectrum will soon carry more data traffic than either wired lines or licensed carrier bands. Cisco's widely-cited Visual Networking Index (VNI), which projects growth in mobile data demand, concluded in its June 1 forecast that by 2015 Wi-Fi devices will actually use more bandwidth than all wired devices combined.[18] Cisco predicts Wi-Fi devices will consume 37.2 exabytes of data worldwide per month in 2015, carrying more than six times as much total data traffic over the airwaves as commercial mobile networks (with 6.3 exabytes per month).[19]

Unlicensed Spectrum Carries an Increasing Share of Mobile Data Traffic

The more recent development driving this trend is the rapidly rising use of unlicensed spectrum by consumers to offload surging mobile data traffic, as well as to boost the speed of mobile broadband applications. Wi-Fi has been essential to the growth in the popularity of smartphones such as the iPhone and is shouldering an increasing share of the capacity load on often under-provisioned licensed wireless networks. Today half of the page views on Apple iPhones come through a Wi-Fi network, as does 92% of iPad web browsing, according to Nielsen research.[20] Overall, Cisco's VNI estimates that roughly 20% of mobile data traffic was routed over unlicensed Wi-Fi in 2010, a share projected to increase to 30% by 2015.[21] Another recent study by Juniper Research projects that 63% of the data traffic generated by smartphones, tablets and feature phones will be transferred onto the fixed network via Wi-Fi and femtocells by 2015.[22] Currently

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[18] Janko Roettgers, "Wi-Fi to Overtake Wired Network Traffic by 2015," GigaOm, June 1, 2011, available at http://gigaom.com/broadband/cisco-wifi-vni-report/.

[19] Cisco Visual Networking Index: Forecast and Methodology 2010-2015, June 1, 2011; available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360.pdf

[20] Kevin C. Tofel, "iPhones, iPads thrive on Wi-Fi, Androids on 3G and 4G," GigaOm, June 23, 2011, available at http://gigaom.com/mobile/iphones-ipads-thrive-on-wi-fi-androids-on-3g-and-4g/

[21] John Leibovitz and Robert Alderfer, "Demand for Mobile Broadband," FCC Blog, Feb. 10, 2011.

[22] Juniper Research, "Relief Ahead for Mobile Data Networks as 63% of Traffic to Move Onto Fixed Networks via Wi-Fi and Femtocells by 2015," April 19, 2011; available at http://www.marketwire.com/press-release/relief-ahead-mobile-data-networks-as-63-traffic-move-onto-fixed-networks-via-wifi-femtocells-1503808.htm

Wi-Fi accounts for over 98% of the mobile data offloaded, a proportion that will remain above 90% even assuming a higher take-up rate for femtocells, which re-use carrier frequencies at low power.

The growing importance of unlicensed spectrum for reducing network congestion and boosting consumer welfare is evident in the recent surge in carriers embracing Wi-Fi:

- AT&T Wireless gives its customers access to 24,000 Wi-Fi hotspots and an increasing number of Wi-Fi "hot zones" in congested areas including Times Square and Chicago's Wrigley Field. Consumers made 107 million connections of AT&T's Wi-Fi network just in the third quarter of 2010, more than in all of 2009.[23]
- Towerstream is deploying a Wi-Fi network of 1,000 base stations, covering seven square miles of New York City, and leasing access to wireless carriers and other companies seeking more ubiquitous bandwidth.[24]
- A consortium of major cable companies – Comcast, Cablevision and Time Warner Cable – have blanketed large parts of New York City with a shared Wi-Fi network and are planning to extend the model in other congested areas along the East Coast.
- Japanese telco KDDI is building out a Wi-Fi network of 100,000 hot spots that will integrate seamlessly with its licensed 4G network to proactively reduce congestion and improve speeds for consumers.[25]

Rural WISPs need unlicensed White Space spectrum to expand coverage

The nation's more than 2,500 WISPs serve more than two million mostly rural and small-town homes, businesses and first responders throughout the country. WISPs, as well as hundreds of Rural Local Exchange Carriers (RLECs), rely primarily on unlicensed spectrum to extend Internet connectivity to unserved and underserved areas – and have long advocated access to the TV White Space because the unique propagation qualities allow it to cover far larger rural areas at lower cost. The ability of WISPs to access unlicensed spectrum without competitive bidding eliminates a significant barrier to entry, thereby benefiting consumers who would not otherwise have access to fixed broadband services. This is why WISPA (the Wireless ISP Association) has been very active in supporting the availability of unlicensed spectrum in the TV bands – ideally a contiguous unlicensed band with wider channels, but at a minimum continued nationwide access to White Space channels, which creates scope and scale to reduce prices for network gear.

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[23] PR Newswire, "Third-Quarter Wi-Fi Connections on AT&T Network Exceed Total Connections for 2009," Press Release (2010, October 22), available at http://www.prnewswire.com/news-releases/third-quarter-wi-fi-connections-on-attnetwork-exceed-total-connections-for-2009-105520733.html

[24] Alan Weissberger, "Metro Wi-Fi Reborn: City Wide Mega-Hot Spot for Mobile Data Offload," IEEE, May 29, 2011, available at http://community.comsoc.org/blogs/ajwdct/metro-wifi-reborn-city-wide-mega-hot-spot-mobile-data-offload

[25] Stacey Higginbotham, "Wi-Fi: it's the other cell network," GigaOm, July 1, 2011; available at http://gigaom.com/broadband/wi-fi-its-the-other-cell-network/

Unfortunately, according to WISP operators the uncertainty stemming from incentive auction legislation is already deterring investments and deployments by WISPs in unserved rural areas. For example, a WISP called RCorn applied for and received an experimental license to deploy on TV white space channels in Kearney and Grand Island, Nebraska, where it already has 3,500 customers for fixed wireless broadband service over unlicensed (using the 2.4 GHz and 5 GHz bands). RCorn's CEO, Russ Hillard, told the FCC that the 900 MHz unlicensed band is fully occupied by farmers, who use it to control tractors, combines and irrigation systems; and the 2.4 GHz unlicensed band is increasingly noisy due to heavy residential use. RCorn tries to make due with 5 GHz unlicensed, but with its superior propagation for rural areas, the TV white space spectrum would both reduce the cost of rural broadband service and greatly improve the quality. Despite receiving an experimental license for the wide-open TV bands, RCorn has put a hold on any further investment until Congress decides if it will uphold or undermine the FCC's Order making unlicensed spectrum available in the TV frequencies nationwide.

Broadband Investment and Deployment on TV White Space is Well Underway

Despite the uncertainties surrounding incentive auction legislation, investments in a wide variety of unlicensed devices and services on the TV White Space spectrum has been advancing since the FCC's initial Order in November, 2008, with substantial fixed broadband deployments and mass marketing of devices expected by early 2012. The sort of fixed, higher-power base stations used by WISPs in rural areas are expected to hit the market by the end of this year, which will make it more affordable for small companies like RCorn. The FCC has already approved nine companies to administer competing geolocation database solutions for managing unlicensed access to the band without interference to broadcasting, a development which has been a prerequisite to certifying devices. These companies obviously anticipate a mass market – both here at home and worldwide – as the unprecedented TV Bands Database tool becomes accepted in the U.S. and around the world to manage access to shared spectrum bands, both unlicensed as well as for secondary market leasing. The Wi-Fi Alliance is projecting that mobile device certification will begin no later than 2013.

In addition, a variety of standards setting groups are close to completing new variations of the IEEE 802.11 Wi-Fi standard to take advantage of the superior TV band propagation characteristics. For example, the 802.22 standard to be published by the end of this year supports the sort of higher-power wide area network deployments in demand by WISPs, whereas the 802.11af standard, expected to be finalized by the end of 2012, enables low-power personal/portable devices and may be the most widely adopted standard as it is built into smartphones, tablets and other mobile computing devices.

After the FCC unanimously adopted the White Space Order, a number of technology companies, cities, universities, utilities, hospitals and other innovators sought experimental licenses to begin testing and demonstrating how "Super Wi-Fi" using the low-frequency spectrum in the TV bands could take unlicensed technologies to the next level. These demonstrations have included:[26]

1) **Rural Unserved Area Deployment: Claudeville, Virginia (population 916)** – Remote Claudeville, in sourthern Virginia, never had a broadband connection until Dell, Microsoft and Spectrum Bridge teamed up, using an experimental license on vacant TV channels. A white space backhaul solution has effectively brought broadband access for the first time ever to this small town where only dial-up Internet access existed until late 2009.[27]

2) **Smartgrid Deployment: Plumas California** – The Plumas-Sierra Rural Electric Cooperative launched the nation's first "Smart Grid" wireless network trial while

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[26] More on these and other examples are on the WIA website, http://wirelessinnovationalliance.com/; and were previously included in testimony by Harold Feld, House Subcommittee on Communications, Technology and the Internet, June 1, 2011.

[27] Nate Anderson, (2009, October 21) *First White Space Broadband Deployment in Small Virginia Town, Ars Technica* (Oct. 21, 2009); retrieved May 28, 2011 from http://arstechnica.com/tech-policy/news/2009/10/first-white-space-broadband-deployment-in-small-virginia-town.ars

simultaneously providing broadband access to the local communities. The Plumas "Smart Grid" wireless network delivers real-time broadband connectivity allowing system operators to manage the electrical system remotely, request critical data from the substations, manage directed power flow, and protect the systems and employees while maintaining the local grid.[28]

3) **Smart City Deployment: Wilmington, North Carolina** - The city is currently relying on white space technology for its "Smart City" initiative, which focused on providing Wi-Fi access to both public safety officials and citizens in public areas with applications that include remote monitoring and management of wetland areas; real-time traffic monitoring to reduce congestion, fuel consumption, travel time and to support local law enforcement during emergency situations.[29]

4) **Hospital Campus Deployment: Logan, Ohio (population 6,704)** - The world's first white space broadband network trial for healthcare providers was launched here, enabling broadband access throughout the hospital, including patient rooms, waiting areas, cafeteria, and meeting rooms.[30]

5) **Public Safety and Tribal Deployment: Yurok Reservation, California** – Until recently the Yurok Reservation in Arcata – California's largest Native American tribe – made due with a single T1 line and connections slower than dial-up. The reservation spans 44-miles of mountainous, heavily forested land presenting many signal obstacles, terrain tailor-made for TV band spectrum, which covers larger areas and penetrates foliage far better that obstructs Wi-Fi at 2.4 GHz. By leveraging its primary public safety use, 70 to 80% of the tribal community now has access to plug and play broadband over White Space spectrum.[31]

6) **Low-Income Housing Deployment: Houston, Texas** – Rice University researchers, with a grant from the National Science Foundation, were able to

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28 Spectrum Bridge (2010, June 23) *Nation's First "Smart Grid" White Spaces Network Trial* [Press release]. Retrieved from http://www.spectrumbridge.com/news/pressreleases/10-06-23/Nation_s_First_%E2%80%9CSmart_Grid%E2%80%9D_White_Spaces_Network_Trial.aspx

29 Anderson, Nate (2010, February 24) *Wilmington, NC Takes White Spaces to Swamp, Ballparks.* [Online] In Ars Technica. Retrieved May 28, 2011 from http://arstechnica.com/tech-policy/news/2010/02/wilmington-nc-takes-white-spaces-to-swamp-ballparks.ars

30 Business Wire, *TV White Spaces Delivering Enhanced Broadband Access and Telemedicine Applications to Healthcare Providers,* Press Release (Sept 14, 2010). Retrieved from http://www.businesswire.com/news/home/20100914005980/en

[31] Carlson Wireless, "California's Largest Tribe Deploys First White Space Broadband for Remote Public Safety Environment," Press Release (June 10, 2011), available at http://www.carlsonwireless.com/about/press-release.php?subaction=showfull&id=1307731549&archive=&start_from=&ucat=1

modify an off-the-shelf Wi-Fi card to use TV white space spectrum to achieve point-to-point transmission distance of one mile (compared to its original 400 to 500 feet), allowing affordable broadband connectivity to low-income residents who previously had no broadband.[32]

7) **Super Wi-Fi Network Deployment: Cambridge, England** – Last month Microsoft led a consortium of British telecom firms, including consortium includes the BBC, British Sky Broadcasting, BT, Nokia, and Samsung, to begin trials on a wireless hotspot network using the freed-up TV channels that the UK, following the U.S. lead, is reallocating for unlicensed use.[33]

The Subcommittee should be clear that an incentive auction mechanism that did not permit the FCC to maintain unlicensed channels in every local market would squander this investment and America's lead in both unlicensed and dynamic spectrum technologies. It is not sufficient to maintain unlicensed access to 'white space' in only rural markets, since without the scope and scale of national markets the costs will be far higher and the degree of innovation much lower.

H.R. 3019: The Spectrum Relocation Improvement Act[34]

Although a comprehensive spectrum inventory would greatly facilitate the identification of bands that can be reallocated for more intensive and efficient use, the process of unlocking unused spectrum capacity should begin immediately on a band-by-band basis. Nowhere is spectrum underutilization more evident than in many of the bands reserved for use by the federal government itself.[35] According to the Commerce Department's Office of Spectrum Management, federal agencies have exclusive use of 18.1% (629

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32 Nate Anderson, *Extending Wi-Fi to one mile, thanks to empty TV channels.* [Online] In Ars Technica. (April 26, 2011), available at http://arstechnica.com/tech-policy/news/2011/04/extending-wifi-to-one-mile-thanks-to-empty-tv-channels.ars

[33] Andrew Parker and Paul Taylor, "Microsoft steps into the spectrum space race," *Financial Times* (June 26, 2011), available at http://www.ft.com/cms/s/0/09864858-a02a-11e0-a115-00144feabdc0.html#ixzz1QQ2BjS7V

[34] This section is adapted from testimony by Michael Calabrese, to the House Subcommitee on Communications, Technology and the Internet, "Legislative Hearing on H.R. 3125, the Radio Spectrum Inventory Act and H.R. 3019, the Spectrum Relocation Improvement Act of 2009," Dec. 15, 2009.

[35] For an in-depth discussion of the utilization of federal spectrum and policy recommendations for reallocation of this underutilized spectrum, *see* Victor Pickard and Sascha D. Meinrath, "Revitalizing the Public Airwaves: Opportunistic Reuse of Government Spectrum," Wireless Future Working Paper, New America Foundation (June 2009); forthcoming in *International Journal of Communications* (2009).

MHz) of the "beachfront" frequencies between 225 and 3700 MHz, while non-federal users have exclusive licenses to 30.4% (1058 MHz). The remaining 51.5% is shared, with federal use primary and private sector use secondary.[36] Of the roughly 2400 MHz of federal spectrum allocations below 3.7 GHz, over 1700 involves radar, radionavigation and air telemetry systems, the effective operation of which are indeed critical to national security. At the same time, actual spectrum measurement studies indicate that the military and other agencies are actually using very little if any of that capacity on most days and in most geographic locations, particularly at ground level and in more densely populated metro areas where more spectral capacity is most needed.[37]

It is important to be clear that just because a frequency band is not fully or frequently utilized in a particular geographic area – which is what the New America and Shared Spectrum Company measurements indicate – this does not mean it is not serving its assigned purpose, or that its incumbent users can be relocated. Many military bands in particular are assigned for mission-critical training and emergency purposes that are episodic or geographically limited in nature. While in many such cases "clearing" a band of its current licensee and reassigning it exclusively to private sector licensees cannot be justified, or could occur only subject to massive exclusion zones (based on an assumption of high-power private use), there is nevertheless tremendous communications capacity that could be productively used without harmful interference to the incumbent – just as the military today shares several radar bands with unlicensed users of low-power unlicensed devices.[38] At the same time, even a band that is "occupied" over the course of a day or week may still have tremendous unused spectrum capacity. A band of frequencies can be "white" (underutilized) and potentially shared on a number of different dimensions, including geography, time, power level, altitude and angle of reception.

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[36] Karl Nebbia, Director, NTIA Office of Spectrum Management, presentation to the Commerce Spectrum Management Advisory Committee (CSMAC), December 9, 2009.

[37] Mark McHenry, "NSF Spectrum Occupancy Measurements: Project Summary," Shared Spectrum Company (August 2005)), available at http://www.sharedspectrum.com/measurements/. McHenry's 2005 study collected frequency use data in six locations along the East coast in 2004 and documented an average total spectrum use of between 0 and 3% at rooftop level across hundreds of MHz of federal spectrum.

[38] *See* Michael J. Marcus, "New Approaches to Private Sector Sharing of Federal Government Spectrum," Wireless Future Program Issue Brief #26, New America Foundation (June 2009).

A band-by-band approach will be necessary to determine the best means by which an underutilized band can be made available for more intensive use with minimum risk of harmful interference to incumbent services. In some bands, Congress or the FCC, in consultation with NTIA, may determine that it is feasible to relocate incumbent federal users to accommodate reassignment of frequencies on an exclusively-licensed basis, as occurred with the 45 MHz of federal spectrum at 1710 to 1755 MHz that was cleared for auction under the Commercial Spectrum Enhancement Act of 2004.[39] In a far larger number of bands, where it is not practical to relocate military or other federal users, or where that would take many years, spectrum capacity can be made available more rapidly by opening the bands to "opportunistic access" on a secondary basis that requires the user to avoid causing harmful interference with the incumbent use.

While we support the improvements to the CSEA that are proposed in H.R. 3019, we believe the legislation should be broadened to address a critical opportunity to free up far greater spectrum capacity for mobile broadband services and innovation. H.R. 3019 would continue to limit eligibility for reimbursements toward the cost of radio system modernization to agencies actually clearing off a set of frequencies scheduled for auction. While only a tiny fraction of federal spectrum could be cleared and auctioned in the near future – primarily because most bands serve critical national security and other functions – a far greater number of bands could be shared more intensively by taking advantage of advances in smart radio technologies. Technologies such as spectrum sensing, dynamic frequency selection, geolocation databases and priority-in-use beaconing can enable a far greater degree of band sharing with non-federal users.

Federal spectrum incumbents need the resources to take affirmative steps to enable more intensive access and band-sharing by other users. This could be a win-win for the military. Although the DoD, for example, has begun sharing military radar bands (at 5 GHz) with low-power unlicensed operations, government users are entirely passive and take no affirmative steps to facilitate private sector use of lightly-used bands. Michael

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[39] On December 23, 2004, President Bush signed into law the Commercial Spectrum Enhancement Act (CSEA), Title II of Pub.L. No. 108-494; 47 U.S.C. 928(d)(2). CSEA created the Spectrum Relocation Fund through which federal agencies can recover the costs associated with relocating their radio communications systems from bands designated by Congress for reallocation to exclusive commercial use.

Marcus, a career-long chief spectrum engineer at the FCC, has argued that with the right incentives "a third generation of sharing could be based on new technologies for federal government radio systems that are designed with sharing in mind and that can actually *facilitate* sharing."[40] New and upgraded federal systems could be designed and procured with the broader public interest in spectrum access in mind – and not only in the very limited case of a band being cleared entirely of federal use.

We therefore suggest that the provisions in H.R. 3019 be amended to broaden the purpose of the Spectrum Relocation Fund – turning it into a sort of revolving fund for modernizing federal systems not only to migrate off a band entirely, but to facilitate the shared or more efficient use of other federal bands. Enhancing agency budgets with revenue tied to the purpose of upgrading to state-of-the-art equipment, we believe, would prove to be a far stronger and more focused incentive than giving agencies the option to lease unused capacity on secondary markets (which, if it ever generated more than trivial amounts of revenue, could not be counted on to increase the agency's overall resources). Funding federal agency relocation plans could remain the priority – and retain access to a guaranteed set-aside within the Fund. But in addition the residual revenue, or some portion, should be made available to applications from agencies that could be recommended to OMB for approval – on an annual, competitive basis – by the new Technical Advisory Panel that would be appointed under H.R. 3019. Moreover, if there were any legitimate concern about auction revenues being insufficient for such purposes, Congress could revise the CSEA to direct that devices certified to operate on the newly-shared bands opened due to expenditures from the Fund pay a one-time certification fee to help replenish the Fund.

Opportunistic Access to Unused Spectrum Capacity

Opportunistic access to unused federal spectrum could be particularly useful given the lumpiness of spectrum demand by geography and population density (e.g., rural vs. suburban vs. urban). The greatest needs for capacity are not nationwide, or around the clock, but primarily urban and during peak use periods. Rather than an entire network needing additional spectrum, it may be a few cells that are substantially oversubscribed and would benefit from having access to additional spectrum for short period of time.

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[40] *See* Michael J. Marcus, "New Approaches to Private Sector Sharing of Federal Government Spectrum," Issue Brief #26, New America Foundation (June 2009).

We believe the most promising mechanism for freeing up large quantities of spectrum capacity needed for wireless broadband deployments and other innovation is to build on the TV Bands Database, which the FCC has certified as the mechanism by which consumers identify and get permission to access "white space" channels not in use in discrete geographic locations across the nation's 210 local TV markets. There appears to be no reason to limit the functionality of this Database to the TV band frequencies – and no reason not to add more fallow bandwidth to this "common pool." If a potentially useful frequency band is not being used at particular locations (e.g., used in New York City but not in West Virginia), or is used only at certain times or at certain altitudes or angles of reception, then that wasted spectrum capacity could at a minimum be listed in the Database for opportunistic access, subject to whatever power limits or other conditions are necessary to avoid harmful interference to sensitive incumbent operations.

Adding other bands to the TVWS Database could ultimately increase available spectrum capacity by hundreds of megahertz or more, particularly in rural areas where measured spectrum usage below 3 GHz is less than 10 percent in most areas today. The FCC's access rules for TV white space anticipates the use of frequency-hopping, multi-band radios, which are increasingly common and affordable in commercial mobile systems. Device makers and service providers would simply choose the combination of frequencies most appropriate to their needs. Devices scan and select the clearest frequency from among those that their devices can be tuned to utilize. Both federal and non-federal bands should be added to the Database, with access to each band subject to conditions that are tailored to avoid harmful interference to existing, licensed use. And to the extent that either a federal agency or private sector incumbents truly need compensation or incentive to facilitate shared access, a permission Database mechanism provides one means by which to collect "user fees." Another means would be to impose a one-time equipment certification fee on devices tuned to operate in bands governed by the Database, since the FCC must certify devices in any case.

Conclusion

Spectrum policy that keeps the United States at the forefront of wireless innovation and ubiquitous, affordable mobile connectivity will need to be about more than raising some short-term auction revenue for the Treasury. U.S. telecommunications policy can best promote innovation, job creation and economic growth over the long term with a policy that keeps the U.S. in the lead on further developing the unlicensed technologies we invented here thanks to forward-looking FCC policies years ago. Unlicensed access to the TV band has already spurred investment by dozens of companies and communities eager to deploy "Wi-Fi on steroids." The consumer, public interest groups, WISPs, entrepreneurs and leading technology companies that comprise the Wireless Innovation Alliance urge the Subcommittee to adopt affirmative provisions that do not auction unlicensed spectrum, but which affirmatively confirm the FCC's authority and obligation to reorganize the TV band to ensure continued unlicensed access to unlicensed spectrum in every local market and nationwide. In addition, many lightly-used Federal bands are particularly well-suited for increased sharing with private sector uses, but this will require more than streamlining the CSEA's Spectrum Relocation Fund process. While H.R. 3019 would be a positive step, an updated version should also broaden eligibility so that Federal agencies have the resources to upgrade systems and other steps needed to share capacity with the private sector on a far greater number of bands.

Thank you again for the invitation to testify. I look forward to answering your questions.

Mr. WALDEN. And we will now move to Mr. Christopher Guttman-McCabe, who is vice president for regulatory affairs, CTIA—The Wireless Association. We look forward to your comments.

STATEMENT OF CHRISTOPHER GUTTMAN–MCCABE

Mr. GUTTMAN-MCCABE. Thank you. And good morning, Mr. Chairman, and Ranking Member Eshoo, and members of the subcommittee. On behalf of CTIA, thank you for the chance to speak to you this morning about the discussion drafts released this week. CTIA believes that this process represents a positive step towards addressing the looming spectrum crisis and ensuring that America's wireless industry remains the world's leader in wireless broadband.

I will not belabor the urgent need to make additional spectrum available. You have seen the studies and heard our analysis, which has been echoed by many others in the wireless and high-tech industries, academia and government. The subcommittee records show that the commercial demand for spectrum is real and pressing, and we are pleased that you are responding. We look forward to supporting you in this effort, which can help us maintain U.S. leadership in this critical industry and stimulate the sort of innovation, economic growth and job creation that our country so desperately needs.

As we read the drafts, we are pleased that they begin the process of addressing the spectrum demand targets below 3 gigahertz articulated in the National Broadband Plan.

We fully support authorizing the FCC to conduct incentive auctions to facilitate the repurposing of bands currently used for broadcast television and other services. The outstanding propagation characteristics associated with the broadcast bands in particular make them ideal for licensed wireless broadband services, and as such would be highly valued by bidders in an auction.

We also strongly support efforts to make the frequencies between 1755 and 1780 megahertz available for commercial use, and to pair that with a band of frequencies between 2155 and 2180 megahertz. A symmetrical pairing of those bands represents the ideal use of this spectrum. We are concerned, however, with any provisions in legislation that do not require that pairing or that may backload the introduction of spectrum identified. Failure to make 1755 to 1780 available or other 3-subgigahertz bands available in the near term will exacerbate the spectrum crisis and encourage consequences that policymakers may find suboptimal.

Providing for spectrum to become available at more predictable intervals will promote certainty, maximize the benefit to the government, and ensure that the U.S. keeps pace with our international trading partners.

We also are concerned about the potential for NTIA to shared use of government spectrum. While the sharing approach is clearly an NTIA priority, CTIA's carrier members consider cleared licensed spectrum that is internationally harmonized and in sufficient block sizes to support mobile broadband applications to be the gold standard.

As a general matter, CTIA believes strongly that auction valuations and, in fact, certainty for bidders will be enhanced by adoption of provisions that limit the ability to condition licenses. Flexible use, unencumbered fungible licenses will drive not only the greatest level of return, but also the greatest level of participation in the auction. The 700-megahertz C-block experience demonstrates clearly that the imposition of regulatory encumbrances not only reduces competition at auction, but also the revenue derived from that auction.

CTIA also strongly supports efforts to address infrastructure issues beyond spectrum. Helping to provide a path to building the tower and antenna infrastructure necessary to make use of that spectrum is extremely important.

We also support steps to provide for cost-based fees for accessing easements and rights-of-way on Federal land, as well as a streamlined access and process to property owned by the Federal Government.

Finally, we urge the subcommittee to include in any bill it moves on this subject additional language that makes improvements to the spectrum relocation process created by the Commercial Spectrum Enhancement Act. Adoption of the template included in the Spectrum Relocation Improvement Act will significantly improve the process of relocating government users.

We believe that addressing these issues will enhance the ability of wireless providers to access additional spectrum, invest in new networks, create jobs and stimulate the economy. We also believe these changes will have a positive impact on the score associated with the legislation.

In closing, let me reiterate a point I made to you when I testified last month, that making spectrum available will pay dividends not just for the wireless industry, but also for the broader American economy. Auction revenues, substantial as they may be, are only part of the equation. Bringing spectrum to market will require investment, both in infrastructure and in jobs, two things our economy can't get enough of at this time. Additionally, the more rapid deployment of high-speed wireless broadband services will encourage innovation and productivity not just in the telecom sector, but across the economy. We have seen this in the areas of smart grid, mobile education, mHealth, intelligent transportation and more.

Thank you again for the opportunity to appear today. We anticipate providing specific editorial suggestions to the subcommittee in the coming days, and we look forward to working with you to move forward with this effort. I look forward to your questions. Thank you.

Mr. WALDEN. Mr. Guttman-McCabe, thank you for being here.

[The prepared statement of Mr. Guttman-McCabe follows:]

CTIA
The Wireless Association®

Expanding the Wireless Frontier

TESTIMONY OF

Christopher Guttman-McCabe
Vice President Regulatory Affairs
CTIA – The Wireless Association®

July 15, 2011

Hearing on
"Legislative Hearing to Address Spectrum and Public Safety Issues"

Before the
House Subcommittee on Communications & Technology

1400 16th Street, NW Suite 600 Washington, DC 20036 Main 202.785.0081 Fax 202.785.0721 www.ctia.org

Testimony of Christopher Guttman-McCabe
Before the House Subcommittee on Communications and Technology
July 15, 2011

Good morning Chairman Walden, Ranking Member Eshoo, and members of the Subcommittee. On behalf of CTIA, thank you for the chance to speak to you this morning about the discussion draft released earlier this week. CTIA believes the draft Spectrum Innovation Act represents a positive first step toward addressing the looming spectrum crisis and ensuring that America's wireless industry remains the world's leader in wireless broadband.

As this represents the third time in the last 18 months that CTIA has visited with the Subcommittee on this subject, I will not belabor the urgent need to make additional spectrum available. You have seen the studies and heard our pitch, which has been echoed by many others in the wireless and high-tech industries, academia, and government. The Subcommittee record shows that commercial demand for spectrum is real and pressing, and we are pleased that you are responding. We look forward to supporting you in this effort, which can help us maintain U.S. leadership in this critical industry, as well as stimulate the sort of innovation, economic growth and job creation that our country so desperately needs.

The 2010 National Broadband Plan (NBP) recognized the need for additional spectrum to be made available for wireless broadband services and called for making 300 MHz available over five years and 500 MHz available over 10 years. As we read the discussion draft, we are pleased that it begins the process of addressing the spectrum demand targets below 3 GHz articulated in the NBP and provides opportunities for licenses to be made available in configurations that would be optimal for high-speed wireless broadband services.

We support authorizing the Federal Communications Commission to conduct incentive auctions to facilitate the repurposing of bands currently used for broadcast television and other services for wireless broadband. Implementation of an incentive auction regime helps move us toward a less constrained market in which it is more likely that spectrum can be put to its highest and best use. The outstanding propagation characteristics associated with the broadcast bands in particular make them ideal for licensed wireless broadband services. On this basis, we believe they would be highly valued by bidders in the forward auction regime described by the discussion draft.

We also strongly support the discussion draft's effort to make the frequencies between 1755 MHz and 1780 MHz available for commercial use and to pair that band with the frequencies between 2155 MHz and 2180 MHz. From our perspective, a symmetrical pairing of 1755-1780 MHz – which is already allocated globally for mobile broadband services - with 2155-2180 MHz represents the ideal use of these bands, which would be internationally harmonized. As Coleman Bazelon of the Brattle Group pointed out in his April 2011 analysis of the AWS-3 band[1], the presence of international synergies would reduce the uncertainty associated with creating devices and software for use in those bands, with the likely effect that such a pairing would be highly valued by bidders and could command (according to Bazelon) $12 to $15 billion at auction.

Auction valuations may be enhanced by adoption of provisions such as those in Section 105 (A)(i) and (A)(ii). The 700 MHz C block experience demonstrates clearly that the imposition of regulatory encumbrances reduces competition at auction and the revenue derived from auction. In the case of the 700 MHz C block auction, the western regional license (covering most of the western United States) sold for significantly less than the unencumbered B block license covering metropolitan Los Angeles and Anaheim, illustrating that regulatory impositions have costs. Extrapolated over the entirety of the 700 MHz auction, this resulted in billions of dollars in lost revenue to the Treasury. Similarly, we would caution against imposition of any sort of wholesale obligations, as it was only after the FCC's mandatory wholesale rules were lifted that the MVNO market began to grow and flourish.

CTIA also supports the provisions in Section 205 of the discussion draft. Making additional spectrum available to licensees only makes sense if there is path to building the infrastructure necessary to make use of that spectrum. Section 205 recognizes the importance of facilities deployment and we support efforts to remove barriers to improving wireless service to the nation's citizens. Despite the strong demand for wireless services and the FCC's November 2009 tower siting "shot-clock" order, zoning delays throughout the country hamper wireless deployment.

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[1] Coleman Bazelon, The Brattle Group, "The Economic Basis of Spectrum Value: Pairing AWS-3 with the 1755 MHz Band is More Valuable than Pairing it with Frequencies from the 1690 MHz Band," April 11, 2011. Available at http://www.brattle.com/_documents/UploadLibrary/Upload938.pdf.

Commendably, the discussion draft seeks to address these delays by balancing the legitimate use of zoning authority with wireless carriers' need to expand coverage, improving capacity and more efficiently utilizing spectrum by upgrading to Fourth Generation ("4G") and future technologies. Moreover, expediting collocation by additional carriers on towers that have already been approved in the zoning process better serves our nation's citizens, maximizes the use of existing towers, and in no way threatens the proper exercise of zoning authority. The draft appropriately seeks to ensure that localities do not unnecessarily stall critical tower siting decisions.

Further, we support steps to provide for cost-based fees for accessing easements and rights-of-way on Federal lands as well as steps to streamline and standardize the application and contracting process through Master Contracts for property owned by the Federal Government. This makes particular sense given that the Federal Government owns 650 million acres (nearly one-third of the U.S. land area) and the General Service Administration owns or leases space in 8,600 buildings. It is our hope that efforts to provide much-needed uniformity, certainty, timeliness, and accountability will result in greater and more expeditious buildout of wireless facilities that will unlock even greater innovation in the wireless ecosystem.

Finally, while it is not part of the discussion draft, we urge the Subcommittee to include in any bill it moves on this subject additional language that makes improvements to the spectrum relocation process created by the Commercial Spectrum Enhancement Act (CSEA). Adoption of the template included in the Spectrum Relocation Improvement Act, which was reported on a voice vote by the Subcommittee on Communications, Technology and the Internet during the 111th Congress, will help ensure that bands reallocated from federal to commercial use are made available in a timely manner and reduce the risks to auction participants by increasing the amount and quality of information available to bidders before an auction of federally-encumbered spectrum.

As we have noted in previous testimony, the CSEA represented an improvement in the previous framework for relocating government users, but the AWS-1 relocation process taught us some valuable lessons that should be incorporated into the discussion draft so that future relocations proceed more smoothly and predictably. Addressing these issues in the same legislation that authorizes repurposing of federal frequencies will promote certainty at auction (with the likely consequence of higher bids) and promote the more rapid deployment of additional wireless broadband services. Conversely, a failure to make adjustments in the relocation process will increase bidder risk and make it more likely that bidders would account for this risk by discounting what they might be willing to pay to acquire licenses in these otherwise highly desirable bands.

While we believe there is a great deal to commend about the discussion draft, there are areas of concern where we think the draft can be strengthened.

First, Section 101 appears to back-load the auction of additional spectrum, deferring auctions for as long as ten years. The NBP identified a need for 300 MHz over the next 5 years because of an anticipated near-term need. For this reason, we urge the Subcommittee to accelerate the reallocation and auction of the 1755-1780 MHz band. Failure to make the 1755-1780 MHz band or other sub-3GHz bands available in the near term will exacerbate the spectrum crunch and encourage consequences that policymakers might find sub-optimal. Providing for spectrum to become available at more predictable intervals throughout the 10-year window established by the discussion draft will promote certainty for providers and maximize the benefit to the government. It also will ensure that the U.S. keeps pace with our international trading partners, many of which have recently made, or will soon make, additional spectrum available in their markets.

We also are concerned that Section 101(c) could inadvertently establish a bias toward shared use of government spectrum other than the 1755-1780 MHz band. While the sharing approach is clearly an NTIA priority based on Administrator Strickling's recent testimony before the Subcommittee, CTIA's carrier members consider cleared, licensed spectrum that is internationally-harmonized and in sufficient block sizes to support mobile broadband applications to be the "gold standard." To the extent that Section 101(c) gives NTIA considerable discretion to promote spectrum sharing rather than spectrum clearing, we believe it creates disincentive for NTIA to clear two key bands - 1670-1710 MHZ and 1780-1800MHz - for commercial use.

While spectrum-sharing may be more convenient for federal users, shared spectrum is of far less potential value than cleared spectrum to wireless companies (a reality that would undoubtedly be reflected at auction through lower bids). CTIA's strong preference would be that Congress reallocate the identified bands below 3 GHz for exclusive commercial use. Barring that, a more stringent test to determine whether some portions of these bands might need to be shared on a geographic basis to protect federal systems critical to our national security may be warranted.

With respect to the incentive auction provisions - Sections 102 and 103 - we urge you to consider two important points. First, we are concerned that the draft may confer upon LPTV stations relocation rights that could substantially complicate repacking and incentive auction efforts by requiring the FCC to reserve spectrum in the VHF band for these stations. As secondary users, LPTV stations affected by repacking should not be able to lay claim to new spectrum.

Second, preventing the FCC from reassigning a TV licensee to another channel except as provided by the discussion draft would undermine ongoing efforts to clear Channel 51. This would harm wireless providers which bid in the 2008 auction and are anxious to resolve Channel 51 interference issues so that they can turn-up service in their 700 MHz band spectrum. This matter is the subject of an ongoing FCC proceeding pursuant to a request for rulemaking filed jointly by CTIA and the Rural Cellular Association and we counsel against any action that would prevent the Commission from resolving the issue.

We believe that addressing these issues will enhance the ability of wireless providers to access additional spectrum, invest in new networks, create jobs and stimulate the economy. We also are confident that addressing these issues as we have suggested would have a positive impact on the score associated with the legislation and provide near- and long-term benefits to the American taxpayer.

In closing, let me reiterate a point I made to you when I testified last month – that making spectrum available will pay dividends not just for the wireless industry, but also for the broader American economy. Auction revenues, substantial as they may be, are only part of the equation, as providers will have to spend billions of dollars post-auction to bring spectrum won at auction to market. This will require investment, both in infrastructure and in jobs, two things our economy can't get enough of at this time. Additionally, the more rapid deployment of high-speed wireless broadband service will encourage innovation and productivity, not just in the telecom sector, but across the economy. These are positive benefits that every member of the Subcommittee should support.

Thank you again for the opportunity to appear today. We anticipate providing specific editorial suggestions to the Subcommittee in the coming days and we look forward to working with you to move forward with this effort. I look forward to your questions.

Mr. WALDEN. I want to thank all of our witnesses for your testimony. And I would just like to note based on something I read this morning about the hiring that is taking place since our draft came out to deal with the unlicensed spectrum piece in the lobby community, we are already creating jobs——

Mr. GUTTMAN-MCCABE. Agreed.

Mr. WALDEN [continuing]. In the private sector. Discussion drafts can have an effect.

I want to start with you, Mr. Guttman-McCabe. First of all, I have got a series of questions, and I am really looking for a yes or no. And this is not a trick. Has the demand for wireless broadband lessened in the last year?

Mr. GUTTMAN-MCCABE. No.

Mr. WALDEN. Has the amount of spectrum available for commercial use increased?

Mr. GUTTMAN-MCCABE. No.

Mr. WALDEN. Has the amount of spectrum available to public safety decreased?

Mr. GUTTMAN-MCCABE. No.

Mr. WALDEN. Nothing has changed. Why would we deviate from the consensus last year that the best way to accomplish our public safety and spectrum goals is to auction the D-block and use the auction proceeds to help fund the public safety network? I can ask that rhetorically.

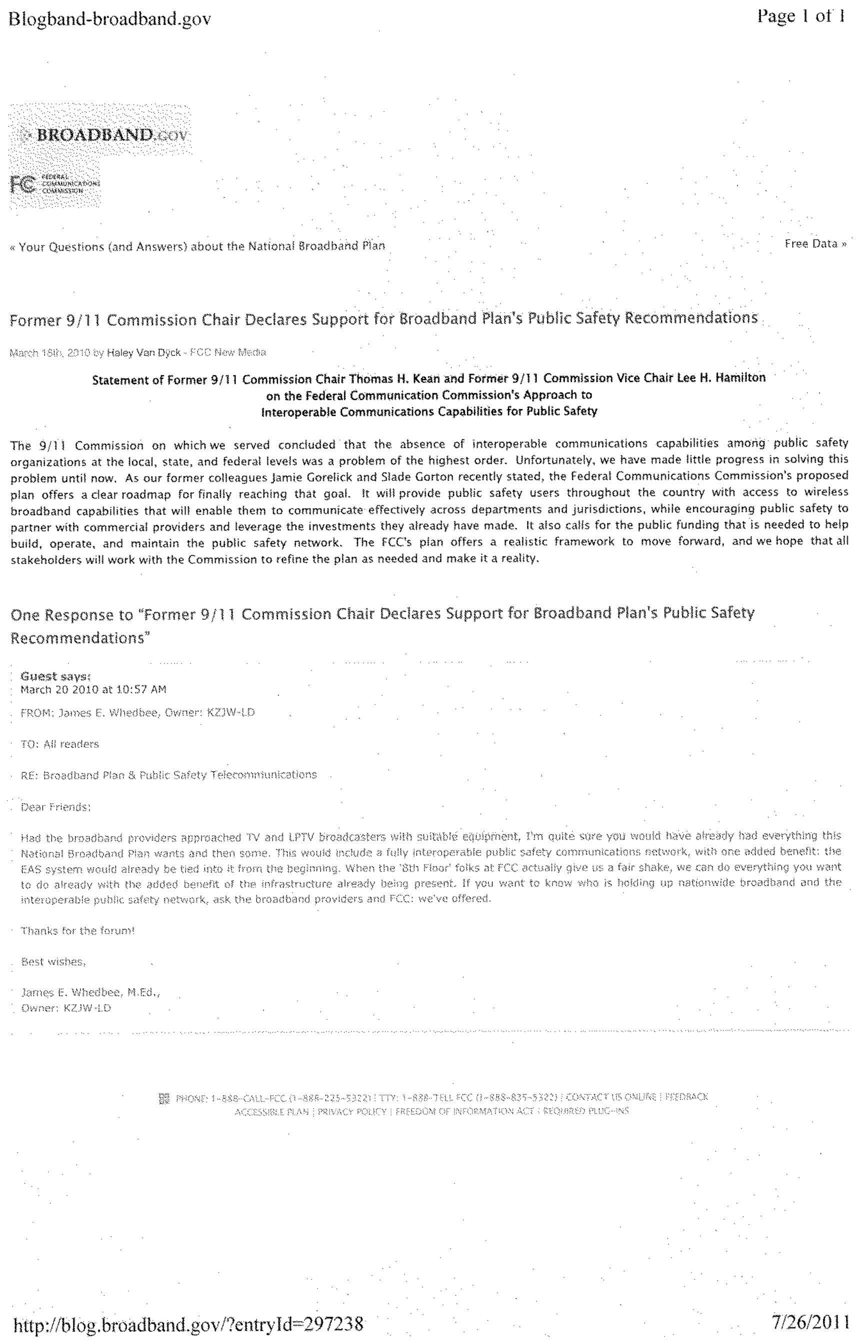
Mr. GUTTMAN-MCCABE. Thank you.

Mr. WALDEN. I request——

Mr. GUTTMAN-MCCABE. I appreciate it, sir.

Mr. WALDEN. I request unanimous consent to enter the following into the record, the following documents all endorsing the FCC's conclusion the National Broadband Plan, that is 24 megahertz, the DTV transition legislation already cleared for first responders is enough, and we should auction the D-block. To wit, a March 2010 FCC blog post from former 9/11 Commission Chair Thomas Kean and Vice Chair Lee Hamilton; and a January 2011 editorial by former 9/11 Commissioner Slade Gorton. Without objection, they will be entered into the record.

[The information follows:]



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« Your Questions (and Answers) about the National Broadband Plan   Free Data »

Former 9/11 Commission Chair Declares Support for Broadband Plan's Public Safety Recommendations

March 18th, 2010 by Haley Van Dyck - FCC New Media

Statement of Former 9/11 Commission Chair Thomas H. Kean and Former 9/11 Commission Vice Chair Lee H. Hamilton
on the Federal Communication Commission's Approach to
Interoperable Communications Capabilities for Public Safety

The 9/11 Commission on which we served concluded that the absence of interoperable communications capabilities among public safety organizations at the local, state, and federal levels was a problem of the highest order. Unfortunately, we have made little progress in solving this problem until now. As our former colleagues Jamie Gorelick and Slade Gorton recently stated, the Federal Communications Commission's proposed plan offers a clear roadmap for finally reaching that goal. It will provide public safety users throughout the country with access to wireless broadband capabilities that will enable them to communicate effectively across departments and jurisdictions, while encouraging public safety to partner with commercial providers and leverage the investments they already have made. It also calls for the public funding that is needed to help build, operate, and maintain the public safety network. The FCC's plan offers a realistic framework to move forward, and we hope that all stakeholders will work with the Commission to refine the plan as needed and make it a reality.

One Response to "Former 9/11 Commission Chair Declares Support for Broadband Plan's Public Safety Recommendations"

Guest says:
March 20 2010 at 10:57 AM

FROM: James E. Whedbee, Owner: KZJW-LD

TO: All readers

RE: Broadband Plan & Public Safety Telecommunications

Dear Friends:

Had the broadband providers approached TV and LPTV broadcasters with suitable equipment, I'm quite sure you would have already had everything this National Broadband Plan wants and then some. This would include a fully interoperable public safety communications network, with one added benefit: the EAS system would already be tied into it from the beginning. When the '8th Floor' folks at FCC actually give us a fair shake, we can do everything you want to do already with the added benefit of the infrastructure already being present. If you want to know who is holding up nationwide broadband and the interoperable public safety network, ask the broadband providers and FCC: we've offered.

Thanks for the forum!

Best wishes,

James E. Whedbee, M.Ed.,
Owner: KZJW-LD

PHONE: 1-888-CALL-FCC (1-888-225-5322) | TTY: 1-888-TELL FCC (1-888-835-5322) | CONTACT US ONLINE | FEEDBACK
ACCESSIBLE PLAN | PRIVACY POLICY | FREEDOM OF INFORMATION ACT | REQUIRED PLUG-INS

The Seattle Times | Winner of Eight Pulitzer Prizes

Originally published Thursday, January 27, 2011 at 3:06 PM

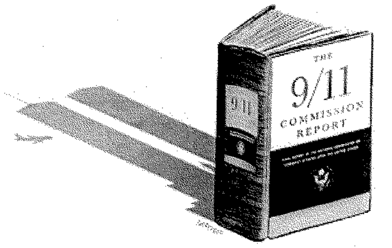
Guest columnist

Congress should implement FCC plan to improve first -responder communications

Guest columnist Slade Gorton, former U.S. senator and member of the 9/11 Commission, urges Congress to implement a proposal that would better provide first responders with communications tools.

By Slade Gorton

Special to The Times



AS a nation, we have seen what can happen when the people we depend on to protect us from harm and danger do not have the necessary tools to do so. On Sept. 11, 2001, paramedics, police and firefighters rushed into the World Trade Center's twin towers without the technology they needed to communicate with each other and navigate the horrific conditions they confronted.

Our nation's inability to provide first responders with the tools necessary to communicate during that crisis was inexcusable, and it was part of the impetus for the formation of the National Commission on Terrorist Attacks Upon the United States (popularly known as the "9/11 Commission") to direct our government to find a solution.

Nine years later, that solution exists. The Federal Communications Commission (FCC) has crafted a realistic plan to auction the 700 MHz D-Block for public safety to a commercial wireless carrier. The current FCC plan would help build a state-of-the-art network for public-safety officials, who currently struggle with disparate abilities to communicate over mismatched equipment.

While the 112th Congress may be sharply divided over many issues, both parties have an opportunity to address this vital national-security priority by supporting the FCC's broadband plan for public-safety communications. Quite simply, I believe it is the best way to guarantee that a national interoperable network is built for first responders in both urban and rural areas.

Some critics of the FCC auction plan have embraced recommendations that call for reallocating the D-Block directly to public-safety officials. As a former member of the 9/11 Commission, I believe their approach offers public-safety officials none of the tools or resources they need to build the network.

As a fiscal conservative, I also believe the FCC auction is more fiscally prudent. According to Rep. Henry Waxman, D-Calif., who chaired the House Energy and Commerce Committee in the 111th Congress and co-authored draft legislation on building a nationwide public-safety network, the best way to start paying for such a network is by dedicating spectrum auction proceeds, including D-Block auction proceeds, to the effort.

The private sector money raised in the D-Block auction could be used to support the construction and operation of the network planned for the spectrum already allocated to public -safety users. Without it, the funds would have to come from the federal Treasury or from state and local governments that are already fighting to make ends meet. As our nation struggles to emerge from the current economic downturn, we must do everything in our power to avoid decisions that contribute to an already massive national budget deficit.

The debate over this issue has now gone on for nearly a decade since Sept. 11, 2001, and for years before that. We no longer can afford to make poor decisions at the expense of our police, firefighters and paramedics. I believe the FCC auction plan is the most realistic and fiscally responsible way for our nation to build this vital communications network.

It's time for Congress to provide our nation's first responders with the support and the technology they desperately need to protect all Americans.

Slade Gorton, a U.S. senator from Washington state from 1981 to 1987 and from 1989 to 2001, served on the 9/11 Commission.

Mr. WALDEN. Mr. Guttman-McCabe, I want to ask you another question. Chief Moore referenced in his testimony the need to act, which we concur with. I have been chairman of this subcommittee for about 6 ½ months now or so, and I think we have had four hearings, a legislative hearing. We have got working documents. We get it. And I am trying to do my best to move this forward in an open, transparent and participatory way so we can get it right, because it is more than just public safety, as you can well appreciate, we are dealing with.

In Mr. Moore's testimony, he urges us to act as if a 9/11 or Hurricane Katrina event had happened just yesterday and fulfill the last recommendation of the 9/11 Commission by allocating the D-block. Could you speak to what happened with the public safety network during 9/11 versus—and I am going to ask Senator Smith this, too—broadcasters during Katrina and the public safety network as it relates to what happened in the cellular network world? What worked and what didn't?

Mr. GUTTMAN-MCCABE. Yes, thank you, Mr. Chairman.

I think this is an area where, too often, people misinterpret what happened on September 11th or what happened in Katrina.

On September 11th, the wireless networks processed more calls than they had ever done, 1,400 percent higher above their highest previous busy time. So they processed calls at an unprecedented rate.

In Katrina—and I was in Gulfport and Biloxi the following day. The day after I had the ability to travel down there with some folks from the Federal Communications Commission. We gave out 40,000 handsets to first responders and others that were down there. So the networks were working.

Mr. WALDEN. Did the public safety network stay up?

Mr. GUTTMAN-MCCABE. To some extent yes, and to some extent no.

Mr. WALDEN. Did your networks stay up?

Mr. GUTTMAN-MCCABE. Our networks did stay up and were pieced back together. Again, that happened in Katrina, and it has happened since then. They are somewhat self-healing networks, and there is the ability for carriers to share spectrum and to share towers, mutual aid agreements, and those were in place and worked very quickly.

Mr. WALDEN. So you were able to have a public-private partnership here to help public safety and help others in that event.

Mr. GUTTMAN-MCCABE. Yes.

Mr. WALDEN. Senator Smith, do you want to comment on the role of broadcasters, briefly?

Mr. SMITH. Clearly, the wireless broadband signal is one-to-one. It is an important piece of the telecommunications world. The uniqueness of the broadcast signal is one to everyone in an area.

A recent example of the power of broadcasting over broadband in an emergency was seen in Alabama, where, according to their Governor, had it not been for live television and radio, the death toll would not have been 250, it would have been many multiples of that. The first thing that went down was broadband. The thing that stayed constant was broadcast. The world of the future must include them both.

Mr. WALDEN. Mr. Guttman-McCabe, didn't the network neutrality and public safety conditions on the C and D blocks in the '08 auction of the 700 meg band reduce the proceeds by billions of dollars and drive smaller wireless carriers out of the market?

Mr. GUTTMAN-MCCABE. Absolutely, Mr. Chairman.

Mr. WALDEN. And wouldn't prohibiting restrictive license conditions, as our staff draft does on the Republican side, be both good for spectrum policy and U.S. taxpayers?

Mr. GUTTMAN-MCCABE. Yes, Mr. Chairman.

And just a quick—the C-block license, which was encumbered, went for $4.7 billion; and it was 22 megahertz, which is a very large license. The immediately adjacent D-block, which was unencumbered and half the size, went for $9 billion. So a license half the size went for twice the price.

Mr. WALDEN. My time has expired. I am going to turn now to my colleague and friend from California, the ranking member of the subcommittee, Ms. Eshoo, for 5 minutes.

Ms. ESHOO. Thank you, Mr. Chairman.

And I want to thank all of the witnesses. I think each one of you, whether I agree or disagree with some parts of what you said, really have offered excellent testimony today and are helping us move forward with this.

To Chief Moore, thank you again for your service to San Jose, California, and the broader Bay area community. I don't represent the City of San Jose, but your leadership is felt throughout the Bay area.

Chief, there have been some recent high-profile disputes involving public safety broadband communications projects, which you are very well aware of. One problem that resonates is a failing of local governance to either preclude such disputes from occurring in the first place or to quickly resolve problems that arise.

In the Democratic draft, you are familiar with what we have placed in that draft relative to governance. Are you confident that the newly created Public Safety Broadband Corporation will be able to maintain national level standards for interoperability?

Mr. MOORE. Yes, Congresswoman. And I must say it is rare that you are going to hear a State, local, either public safety or the mayors and nationally the cities, say we want more governance from the Federal Government. It is very rare indeed.

Ms. ESHOO. Yes. Exactly. Be careful what you ask for, or wish for.

Mr. MOORE. Given what we have experienced over the years, particularly with respect to interoperable communications, it became clear to all of us in the last 2 years that there needs to be some level of national presence in respect to governance to make sure that interoperability standards are set and are met before large—literally billions of dollars are spent. Otherwise, we are going to see a patchwork like we have seen in the past, and everybody is comfortable with that.

Ms. ESHOO. Thank you.

To Professor Cramton, thank you for your excellent, excellent work, all that you have done, all that you have published. It is really quite stunning, the work that you have done. So I haven't read all of it. I have read some of it, and I am glad that you are devoted to this in your professional life.

As we all know, the wireless industry is moving toward using LTE for 4–G communication throughout the 700 megahertz band. As an expert economist—and that you are—what are the specific economic benefits of device interoperability across the spectrum—as quickly as you can.

Mr. CRAMTON. So the main thing is competition. To get auctions to work, we need competition. And in fact that was the problem with the price disparities in the 700.

Now, to get markets to work, we need competition, and that is a challenge in network industries where there is enormous fixed costs of building networks. What interoperability does is it fosters competition by creating a more level playing field.

What we have seen in the 700 megahertz auction is, when the auction was conducted, the bidders all expected interoperability, because that is the way it was in all the prior auctions. In this auction—and so nobody thought that there needed to be a requirement of interoperability. It was just assumed that it would be there. In this auction, after the auction, one of the large winners, AT&T, lobbied and created a new band, band 17, that excludes the A-block winners. There is a band 12 that includes both the A-block and the D-block, and what happened was AT&T decided to build devices that were just specific to the spectrum that it won, and Verizon did the same thing.

This is problematic because it basically makes the spectrum won by the A-block winners worthless. They can't get equipment because of the enormous economies of scale in the building of equipment. So that is the big problem.

Ms. ESHOO. Do you think that the majority's discussion draft allows enough flexibility for the FCC to conduct an efficient incentive auction?

Mr. CRAMTON. I think there are a number of clauses that need to be eliminated that are restrictions that get in the way of an efficient auction. The reality is that this is an extremely complicated auction and no one, not even the best experts, knows right at this instance how all the questions should be resolved.

So it is very important for the legislation to focus on the broad principles and I would say only address these broad principles given the outstanding track record that the FCC has with respect to its auction program. And especially I know, on the incentive auctions, they have actually been working hard for the last couple of years, you know, getting ready for this, and they are actually all set to engage the experts and really make this work. But we can't have things stand in the way.

Ms. ESHOO. Thank you.

I have other questions that I would like to ask, but I am out of time, so I will submit them in writing. But I want to thank those that I didn't get to ask questions of for your excellent testimony.

Mr. WALDEN. We will probably all have those going forward, depending upon our time today.

Mr. Shimkus for five.

Mr. SHIMKUS. Thank you, Mr. Chairman.

Mr. Chairman, I want to congratulate you for putting a panel that all agrees—they all agree there is something they don't like. I was back in the back room with staff, and it is a great panel.

The spectrum is a great asset. We all need to use it effectively. There is just obviously a divergence into what that is. So I applaud you all and the testimony.

Just before I go into my question, our national debt is really the threat, and that is really what is encumbering all our discussions here in Washington right now. I mean, we are doing all our other work. And the reality is our budget consists of Medicare, Medicaid, Social Security, interest on the debt, and discretionary budget. And if we don't address the entitlement programs, regardless of what we do, they are going to consume all the discretionary budget. In fact, we could take away the discretionary budget and we are still going to have a debt threat in this country.

So that is just a plain economic fact of the challenges that we are facing. That is kind of rolling into this debate. We have to understand, if we want money to go to public safety, if we don't control the debt, there is not going to be additional money.

I am a big Fire Act grant guy. It has been great for rural America and my small communities. So that is why I think this might be part of it, if and when we get to a vote on some solution to this. But I do appreciate all of the panel, because it is very enlightening.

I would like to ask unanimous consent, Mr. Chairman, to enter into the record the FCC Office of Plans and Policy Working Paper Number 43 on unlicensed auctions.

Mr. WALDEN. Without objection.

[The information follows:]

Federal Communications Commission
Office of Strategic Planning and Policy Analysis
445 12th Street, SW
Washington, DC 20554

OSP Working Paper Series

43

A Market-based Approach to Establishing Licensing Rules: Licensed Versus Unlicensed Use of Spectrum

February 2008

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Mark A. Olson
William W. Sharkey

A Market-Based Approach to Establishing Licensing Rules: Licensed Versus Unlicensed Use of Spectrum

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[*] Mark Olson participated in this project under a contract with the FCC. This document is available on the FCC's World Wide Web site at http://www.fcc.gov/osp/workingp.html.

[†] The authors would like to thank Ronald Chase, Gregory Crawford, Ira Keltz, Julius Knapp, Evan Kwerel, Ahmed Lahjouji, William Lehr, Jonathan Levy, Martha Stancill, and Weiren Wang for very helpful comments on an earlier draft. We would also like to thank Kenneth Carter for early helpful comments on the project.

Abstract

The FCC uses an administrative process for identifying the most desirable set of licensing rules for spectrum. Spectrum designated to unlicensed use is made freely available for uses which comply with appropriate technical standards. Spectrum allocated to licensed use is generally awarded to private parties through an auction mechanism. The allocation between licensed and unlicensed use, however, is based on the FCC's judgment, which in turn relies on information provided by interested parties who seek to use the spectrum. One method of reducing the incentive that parties have to exaggerate the value they place on a given regime involves creating a market for such rules. We examine the feasibility of using a "clock auction" to determine, based on the bids submitted by market participants for the corresponding licensing rules, the efficient allocation of a given amount of spectrum between licensed and unlicensed spectrum use. Analysis indicates that market forces, in the form of a clock auction, can be used to determine the efficient assignment of license rules to spectrum.

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1 Introduction

Like many other telecommunications regulatory bodies, the Federal Communications Commission (FCC) uses an administrative process for identifying the most desirable set of licensing rules for a given band of spectrum. An important recent example involved the use of that process in establishing licensing rules for 22 MHz in the 700 MHz band.[3] Here, the FCC faced the highly contentious issue of whether to impose an "open" versus a "closed" platform requirement on the license owner of such a block. Under an "open" platform requirement, the license owner would be prohibited from restricting the set of wireless devices that a customer can employ on the licensee's network and the applications the customer can access via that network.[4] In contrast, under a "closed" platform regime, the license owner would not be so prohibited. Traditional service providers (e.g., Verizon, AT&T) argued strongly that the platform should be closed, while several interested parties (e.g., Google, Skype, Frontline Wireless) maintained that the platform should be open.[5]

Some regulatory bodies have expressed substantial dissatisfaction with the use of an administrative process to make such decisions.[6] The dissatisfaction stems, in part, from the manner in which the process obtains information on the value users place on alternative spectrum license rules. In contrast to a market mechanism, where users pay a price for having their needs met, an administrative process relies simply on the reported needs of interested parties. Because of the cost of misrepresenting one's needs is small relative to the potential private value of spectrum acquired, each user has an incentive to exaggerate the value he/she places on a given set of licensing rules, as well as how much spectrum to which those rules should apply.

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[3] See Federal Communications Commission, *Second Report and Order*, WT Docket No. 07-132, July 31, 207. Another example involves the identification of the most efficient set of license rules for Advanced Wireless Services in the 2155-2175 MHz Band. See Federal Communications Commission, *Notice of Proposed Rulemaking*, WT Docket No. 07-195, September 19, 2007.

[4] Currently, carriers typically restrict the models of cell phones that can be employed on their networks as well as the software that can be downloaded onto the cell phones that can be employed on their networks.

[5] On September 13, 2007, Verizon filed a suit before the U.S. District Court of Appeals for the District of Columbia arguing that the FCC's open access requirements were unlawful. On October 23, 2007, Verizon decided to drop its lawsuit after losing its appeal for a speedy resolution on October 3, 2007. On that same day, the Cellular Telephone Industry Association (CTIA) stepped in to challenge the same regulation in a lawsuit before the Court. See "CTIA Takes UP 700 MHz Challenge," *RCR Wireless News*, October 26, 2007.

[6] The European Commission has recently stated that an administrative process for determining licensing rules is neither transparent nor objective. See *Study of Legal, Economic & Technical Aspects of "Collective Use of Spectrum" in the European Community – Final Report*, by Mott MacDonald Ltd., Aegis Systems Led., IDATE, Indepen Ltd, and Wik Consult (November 2006), pg 13. Recently, Professor Martin Cave called the administrative approach to determining license rules "arbitrary and unsatisfactory." See "New spectrum-using technologies and the future of spectrum management: a European policy perspective," by Martin Cave, in *Communications: The Next Decade,* edited by Ed Richards, Robin Foster and Tom Kiedrowski, Ofcom (November 2006), pg. 224.

Therefore, identifying the most desirable set of licensing rules involves both measuring an interested party's "need," and determining the magnitude by which interested parties have exaggerated their license rule needs. The FCC's license rule assignment problem is similar to other assignment problems where an administrative process is used to identify the best use of a given resource. For example, city planners are often confronted with the problem of determining whether a given parcel of land should be designated to public or private use.

The FCC's license rule assignment problem is an example of a broader class of "incentive problems" that have been considered in the economics literature. In this instance, a potential solution involves creating a mechanism that induces interested parties to reveal their private information regarding the value they place on spectrum and the licensing rules that apply to that spectrum. One approach, which is explored in this paper, involves the creation of a market for licensing rules in which participants bid to have their licensing rule needs met. By reducing the incentive that interested parties have to misrepresent their economic interests, this approach may substantially improve the efficiency of the licensing process and, thus, the economic benefit society receives from one of its most valuable resources.

Licensing rules come in a wide variety of flavors. We examine, using experimental methods, the issue of whether a particular market form can determine an efficient designation of a given amount of spectrum between licensed and unlicensed use. Specifically, we experimentally examine the ability and willingness of market participants to compete, via a clock auction, to have a number of homogeneous units of spectrum designated to licensed versus unlicensed use. The clock auction is an ascending price auction wherein bidders reveal to an administrator the number of blocks of spectrum they wish to "acquire" at different clock prices established by an administrator. The auction concludes when the demand for spectrum is consistent with the available supply at that clock price. Because each bid is associated with a given license regime, the identification of the efficient assignment of spectrum simultaneously determines the efficient set of licensing rules for the blocks of spectrum up for auction, given the bids submitted in the auction. Once the efficient allocation of spectrum is identified, a simple rule determines the price(s) paid by winning bidders.

2 Modeling Licensing Rules – Licensed and Unlicensed Operations

As part of its spectrum management responsibilities the FCC determines the set of rights that are assigned to a given block of spectrum used by commercial and non-commercial entities.

At one end of the spectrum rights regime are unlicensed operations. Under unlicensed operations, spectrum is treated as an open access resource that is available to all without charge.[7] Each user is free to demand as much spectrum as he/she wishes employing the appropriate FCC-certified equipment, which operates at the authorized power levels. However, the service quality, in terms of transmission speed, jitter and packet loss, experienced by a given user depends on the total spectrum demand of all users. In particular, if the sum of the demands that users place on the available spectrum is less than some percentage of the available supply, the quality of service is satisfactory for all users. On the other hand, if total demand for spectrum exceeds the available supply, spectrum is assigned to the competing users in a manner that reduces the quality of service for all.[8] The most successful example of unlicensed operations is Wi-Fi service, a service that operates in the 900 MHz, 2.4 GHz, and 5.8 GHz bands and which is employed by millions of users each day to access the Internet.[9]

At the other end of the spectrum licensing regime are licensed operations. Under licensed operations the license owner is granted the right to determine the service to be offered, the technology to be employed to provide that service, and the right to exclude non-payers from accessing his/her service. In addition, the license owner is assigned a right that protects his/her service from harmful interference from other service providers, as well as the right to sell his/her license to another party. A prominent example of licensed operations is the highly successful Personal Communications Service which operates in the 1.9 GHz band.

In modeling the licensing rule problem, we assume that, as a result of its engineering and policy analysis, the FCC has established a set of technical performance parameters, including maximum power and out-of-band emission limits, for a set of four bands of spectrum located in a single geographic area (see Figure 1).[10] We further assume that, as part of its traditional spectrum management responsibilities, the FCC is confronted with the problem of identifying whether each block should be designated to either licensed or unlicensed operations, and, for licensed operation it must further identify the user(s) that most highly value the block(s). The current analysis assumes that equal power is designated for all block of licensed or unlicensed spectrum.

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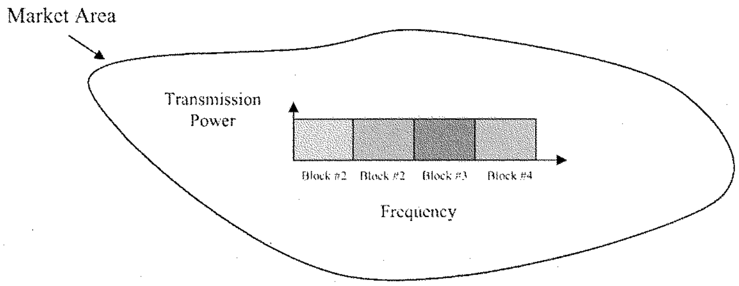
[7] While spectrum is available to makers of FCC authorized devices without charge, whether spectrum is fee to users depends upon the service and the business enterprise. For example, Panera Bread offers free Wi-Fi service to its customers, while Starbucks does not.

[8] Because of differences among spectrum users on the effect spectrum congestion has on the value they place on spectrum, the economic relationship between quality of service, spectrum congestion, and valuation is more complicated in actuality than specified here. For a discussion of this economic relationship, see Bykowsky, M., Olson, M., and Sharkey W. (2008) "Modeling the Efficiency of Spectrum Designated to Licensed Service and Unlicensed Operations," *OSP Working Paper #42*. Some writers use the word "interference" to describe the problem of spectrum congestion. See Stuart Benjamin (2003), "Spectrum Abundance and the Choice Between Private and Public Control," *New York Law Review*, vol. 78, Number 6, pgs 2007-2102.

[9] More precisely, the FCC has authorized devices to operate on an unlicensed basis in these bands. Moreover, technological improvements continue to enhance the transmission capabilities of spectrum designated to unlicensed operations. Such improvement may in the future prove effective in enhancing competition in the broadband access marketplace.

Figure 1: Hypothetical Band Plan



3 Modeling Auction Participant Type

In an auction to allocate spectrum between licensed and unlicensed use, participating firms fall into two distinct categories as a result of differences in their business models. The business model of "L-Type" firms (e.g., Verizon, AT&T, T-Mobile) involves constructing the necessary telecommunications infrastructure and earning a return on that investment based on revenue obtained from subscribers. Consequently, all L-Type firms strongly prefer to acquire spectrum with licensing rules that enable them to exclude non-payers and to receive protection from harmful interference from other service providers.

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[10] Spectrum congestion is a problem for all service providers, regardless of whether they utilize spectrum designated to licensed use or spectrum designated to unlicensed operations. However, due to the free entry conditions of unlicensed operations, congestion is considered a greater problem under unlicensed operations than licensed use. To reduce the likelihood of congestion, the FCC typically authorizes a lower power limit for unlicensed operations than licensed use. Nevertheless, we assume in this analysis that there is no difference in authorized power levels between the two service types. The assumption is appropriate if certain enforceable congestion protocols are established within the unlicensed spectrum bands. For a discussion of several possible protocols, see Bykowsky, M., Carter, K. Olson, M., and Sharkey W. (2008) "Enhancing Spectrum's Value Through Market-informed Congestion Etiquettes," *OSP Working Paper #41*. For a discussion of the incentive equipment manufacturers have to design unlicensed devices that are "greedy," thereby increasing the likelihood of spectrum congestion, see Peha, Jon, " Spectrum Sharing Without Licenses: Opportunities and Dangers," in *Interconnection and the Internet: Selected Papers From the 1996 Telecommunications Research Conference*, G. Rosston and D. Waterman (Eds). Mahwah, N.J.: Lawrence Erlbaum Associates, 1997, pgs. 49-75.

Another type of bidder – a "U-Type" firm – has a preference for licensing rules that promote free, open access to spectrum. A variety of firms fall within the U-Type category. Rather than derive revenue from subscribers, one class of U-Type firms earns revenue from advertisers and/or retail customers that sell good/services to customers via the Internet. The most prominent examples are firms (Ask.com, Google, Microsoft, Yahoo) that obtain revenue from selling to advertisers access to viewers/listeners that are attracted to Internet-based content and services. Another class of U-Type firm (Cisco, Fujitsu, Juniper Networks, Motorola) obtains revenue from selling hardware (e.g., wireless routers) to firms that provide Wi-Fi service (Marriott Hotels, Panera Bread, Starbucks) or obtains revenue directly from consumers that purchase products (e.g., cellular handsets or automatic garage door openers) that utilize spectrum designated to unlicensed operations.

The greater the number of viewers or users to which a U-Type firm can obtain access, all things being equal, the greater the value it places on licensing rules that provide for non-exclusive, open access use. It also follows that the greater the demand for a product that is necessary to either provide Wi-Fi service or to enable consumers to utilize spectrum designated to unlicensed operations, the greater the value the U-Type firm places on licensing rules that provide for non-exclusive, open access use. Because market participants vary in the demand for their products, as well as in their profit margins, U-Type firms will vary in the value they place on having spectrum allocated to unlicensed operations, but they nevertheless have a common interest in obtaining spectrum authorized for unlicensed use.

4 Modeling Bidder Preferences and Valuations

Under the current FCC administrative process to determine the amount of spectrum assigned to market participants, it is possible that the spectrum assigned to any given user is less than what that user desires. This mis-estimation makes it likely that market participants will desire multiple blocks of spectrum. However, legitimate concerns about system congestion also create a demand for multiple blocks for any given user.[11] Because of diminishing marginal revenue product considerations, the value each firm places on the first block of spectrum may exceed the value a firm places on additional blocks of spectrum.[12] In addition, given the stronger ownership and use rights associated with spectrum designated to licensed versus unlicensed operations, our model assumes that L-Type firms uniformly place a higher value on a block of spectrum than U-Type firms.[13]

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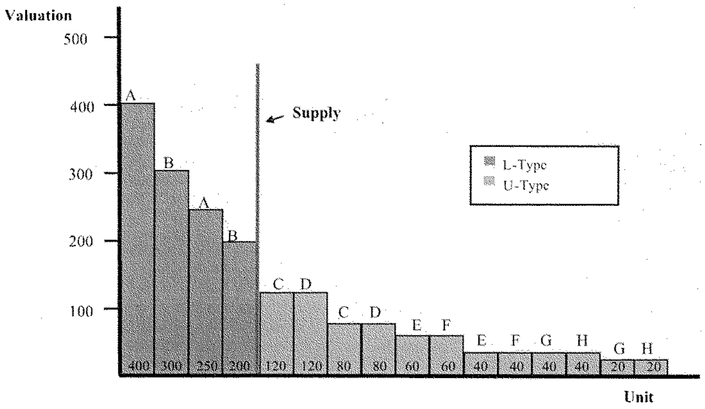
[11] See Bykowksy, et al. (2008), *op cit.*

In this analysis, the actual values assigned to market participants are driven less by actual market valuation considerations derived from empirical data than by a desire to stress test our market approach to achieving the efficient allocation of spectrum. In particular, we wish to establish a valuation environment that tests whether the proposed mechanism efficiently designates spectrum to unlicensed operations when it should clearly do so. Moreover, we wish to establish a valuation environment that tests whether the mechanism finds the efficient set of license rules when to do so is highly problematic. To that end, we have established two valuation environments. Under one set of valuations (Session 1), there are two L-Type bidders (A and B), and six U-Type bidders (C through H). Figure 2 shows the distribution of valuations across these bidders in this environment.

Figure 2: Session 1 Valuations



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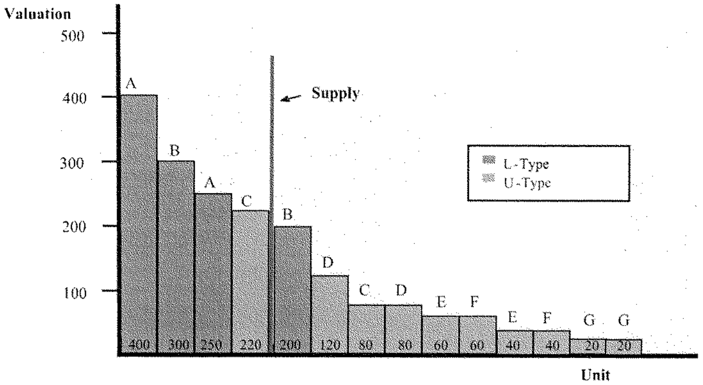
[12] A market participant's demand for spectrum is derived from the demand consumers express for the participant's wireless service. In a competitive market, consistent with a firm's attempt to maximize its profits, a firm will acquire spectrum to the point where its marginal revenue product of spectrum is equal to its cost.

[13] The fact that a U-Type firm has never participated in a spectrum auction, let alone place a winning bid in an auction, provides weak proof that up to now U-Type firms place a lower value on a given block of spectrum than L-Type firms.

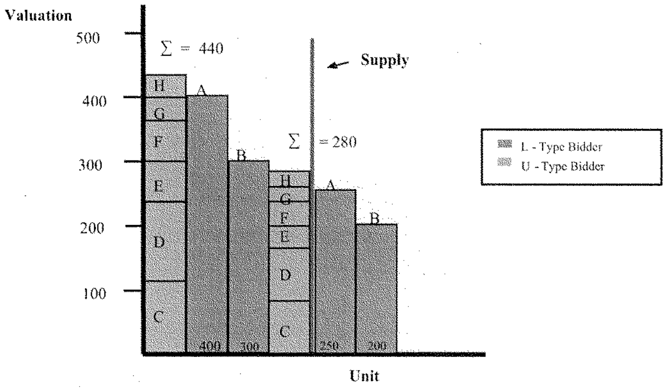
Under another set of valuations (Session 2), there are two L-Type bidders, and five U-Type bidders. Figure 3 shows the distribution of valuations across these bidders in this environment.

Figure 3: Session 2 Valuations



Because each bid is associated with a given license regime, the identification of the efficient assignment of spectrum simultaneously determines the efficient set of licensing rules for the blocks of spectrum up for auction and the set of winning bidders, given the bids submitted in the auction. Identifying the economically efficient set of licensing rules involves measuring the value society would receive from each set of license rules. The value society obtains from having one or more blocks of spectrum allocated to licensed operations is equal to the value L-Type firms place on licensed operations. In contrast, the value that society obtains from having one or more blocks of spectrum designated to unlicensed operations, given their unfettered open access nature, is equal to the summation of the valuations that U-Type subjects place on having such a designation. Figure 4 shows the efficient assignment of spectrum, including the efficient set of licensing rules, involving Session 1's valuation set. As shown, efficiency considerations dictate that one block of spectrum be assigned to subjects A and B (for licensed operations) and two blocks of spectrum to subjects C – H (for unlicensed operations).

Figure 4: Session 1 Efficient Assignment



The objective of our analysis is to examine – in proof of concept terms – whether a market can be used to allocate spectrum between licensed and unlicensed operations.[14] At the minimum, the chosen market mechanism should designate spectrum to unlicensed operations where it is obvious, from an efficiency perspective, that it should do so. Here, we define the level of "obviousness" by the size of the discrepancy between the value U-Type bidders place on having spectrum designated to unlicensed operations and the value society would receive from having the extra-marginal unit included in the allocation. For example, as shown in Figure 4, the sum of the values U-Type subjects place on having spectrum designated to unlicensed operations (i.e., 440) is substantially greater than the value Subject A places on a second block of spectrum (i.e., 250). Therefore, in this environment a successful mechanism is one that nearly always designates at least one block of spectrum to unlicensed operations.

Ideally, the chosen market mechanism should also designate spectrum to unlicensed operations in instances where just a small amount of under-revelation by U-Type participants would cause the market to designate spectrum to licensed operations when efficiency considerations dictate it should be designated to unlicensed operations. One measure of the degree of difficulty U-Type firms will have in overcoming the under-revelation problem is represented by the amount of value they collectively must give up in order to obtain a given amount of value. How much value U-Type firms need to give up depends on the mechanism's pricing rule. As will be discussed later, under the proposed mechanism all blocks of spectrum are sold at a uniform price which is equal to the highest rejected bid. For example, as shown for Session 1 in Figure 4, in order for U-Type firms to collectively obtain 30 units of value from having a second block of spectrum allocated to unlicensed use (i.e., 280 -250), they must give up 250 units of value (88% of the combined total value).

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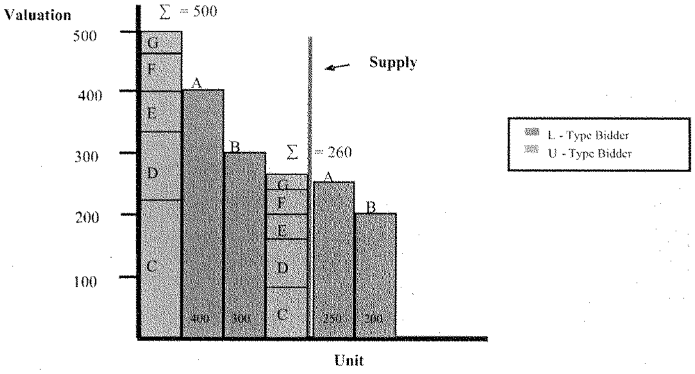
[14] A Proof of Concept is a realization of a given process or technique that is designed to demonstrate the feasibility and workability of a set of core ideas.

Figure 5 shows the efficient assignment of spectrum, including the efficient set of licensing rules for Session 2's valuation set. As before, efficiency considerations again dictate that one block of spectrum should be assigned to bidders A and B under licensed operations, and two blocks of spectrum to bidders C – H under unlicensed operations. As measured by the difference in value between the fifth highest valuation (i.e., 250) and the value U-Type bidders collectively place on having a first block of spectrum allocated to unlicensed operations (i.e., 500), a successful mechanism is one that consistently designates at least one block of spectrum to unlicensed operations. While the Session 2 two valuation environment poses less of an allocation challenge for the market mechanism regarding the first block of spectrum, it is substantially more difficult than Session 1 regarding the second block of spectrum. As shown in Figure 5, in order for U-Type bidders to obtain 10 units of value (i.e., 260 – 250) from having a second block of spectrum allocated to unlicensed use, collectively they must give up 250 units of value (96% of the combined total value).

Figure 5: Session 2 Efficient Assignment



5 Market Mechanism – A Clock Auction

Experiments conducted for other spectrum auctions have revealed that bidders may engage in "jump bidding" in an ascending English auction in an effort to forestall or signal competition and, as a result, may lead to an inefficient assignment of items.[15] More recently, analysis indicates that the threat of financial exposure increases the likelihood of this behavior during a simultaneous multiple round auction involving multiple heterogeneous items.[16] Moreover, jump bidding appears to be a significant feature of FCC spectrum auctions.[17] One solution to this problem is a "clock auction." A clock auction is an iterative auction procedure where bidders express there willingness to pay for one or more units of an item based on prices established by the auctioneer and where a set of rules determines the efficient allocation and a set of market clearing prices.

In this study we propose a new auction mechanism that is based on, but not identical to, previous clock auctions.[18] The proposed auction begins with the Auctioneer (e.g., the FCC) announcing a single opening price – the clock price – for each spectrum block up for auction.[19] Subjects respond by identifying the number of blocks they wish to acquire at that clock price. All responses, including the identities and license regime preferences of bidders, are kept private. A simple set of rules enables the auctioneer to assess the value bidders place on having one or more blocks of spectrum designated to licensed versus unlicensed operations.

1. If a bidder requests zero blocks at the initial clock price, then the value the bidder places on the first and second blocks of spectrum is equal to zero.
2. If a bidder requests one block of spectrum at the initial clock price, then the value the bidder places on a second block of spectrum is equal to zero.

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[15] Jump bidding occurs in an ascending bid auction when one or more bidders place bids in excess of the minimum bid increment established by the auctioneer. See McCabe, K., Rassenti, S. and Smith, V. (1988) "Testing Vickrey's and other Simultaneous Multiple Unit Versions of the English Auction," revised by Isaac, R.M., ed. (1991) *Research in Experimental Economics* (JAI, Greenwich, CT), vol. 4. See also Avery, C., (1998) "Strategic Jump Bidding in English Auctions," *Review of Economic Studies*, Vol. 65 (2), pgs 185-210.

[16] Porter, D, Rassenti, S, Roopnarine, A, and Smith, V., (2003) "Combinatorial Auction Design," *Proceedings of the National Academy of Sciences*, vol. 100.

[17] Cramton, Peter, (1997), "The FCC Spectrum Auctions: An Early Assessment," *Journal of Economics and Management Strategy* Vol. 6(3), pgs. 497-527.

[18] The primary focus of our research, however, is directed to the feasibility of using a market mechanism to designate spectrum to either licensed or unlicensed use. We leave it to further analysis to determine the most appropriate auction design for this purpose.

[19] The number of clock prices is equal to the number of heterogeneous items. For simplicity, we have assumed that blocks up for auction were homogeneous.

3. To preserve the increasing price nature of the auction, bidders are prevented from increasing the number of spectrum blocks they desire as the clock price increases.
4. If a bidder reduces his/her spectrum block demand from two to one as the clock price increases from one level to the next, the lower clock price represents the value the bidder places on a second block of spectrum.
5. If a bidder reduces his/her spectrum block demand from one to zero blocks as the clock price increases from one level to the next, the lower clock price represents the value the bidder places for a single block of spectrum.
6. For subsequent rounds, if a bidder reduces his/her spectrum block demand from two to zero blocks in response to the latest clock price increase, the lower clock price represents the value the bidder places for both the first and second blocks of spectrum.

If the number of blocks desired by one or more bidders exceeds zero at a given clock price, the "clock ticks up" – meaning that the price for a block of spectrum goes up by a predetermined amount.[20] Subjects are then given the opportunity to reveal to the auctioneer (and not to the market) the number of blocks they desire at that clock price. The auction closes when there is zero demand for a spectrum block at the going clock price.

5.1 Allocation Rule – Aggregate Bid Rule

When the auction concludes, the allocation of spectrum and the prices paid by winning bidders can be easily determined. The efficient allocation of spectrum across license regime type and users requires comparing, based on the represented willingness to pay of bidders for spectrum designated to different use types, the value society will obtain from designating spectrum to licensed versus unlicensed use. In contrast to licensed use where license owners have exclusive use rights to the allocated spectrum, unlicensed users have unfettered access to spectrum designated to unlicensed operations. The open access provision of unlicensed operations requires that we apply the same "non-exclusive" treatment to the bids submitted by bidders that wish to see spectrum designated to unlicensed operations. Such treatment requires that we aggregate the bids U-Type bidders place in the auction. In our model, where bidders desire to have multiple blocks of spectrum designated to a given license regime and where they have different willingness to pay across these blocks, such aggregation must be performed with care. For example, because U-Type bidders may express a higher valuation for a single block of spectrum than for a second block of spectrum, such bidders are submitting to the auction two distinct bids – one type applies to a single block of spectrum, while another type applies to a second block of spectrum.[21] Forming the correct aggregate bids requires keeping this distinction in mind. To this end, a simple algorithm adds together the highest bids from each U-Type bidder to form one aggregate bid – (U1). In addition, a simple algorithm adds together the lowest bids from each U-Type bidder to form a second aggregate bid (U2).

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[20] In most clock auctions, the clock price only ticks up if the demand for the auctioned item exceeds its supply. See Porter, et. al. (2003) *op cit.*

Once the two aggregate bids are constructed, identifying the efficient allocation of spectrum to license rule regime and, in the case of licensed operations, to the most efficient user(s) is straightforward. Under the allocation rule, bids U1 and U2 are ranked, along with the bids submitted by L-Type bidders, from highest to the lowest. Given that there are four blocks of spectrum up for auction, the four highest bids are each assigned a single block of spectrum. Because each bid is associated with a given license regime, this assignment also determines whether a block is allocated to either licensed or unlicensed operations. For example, if the U1 and U2 bids are among the four highest bids, two blocks are designated to unlicensed operations. If the four highest bids include two bids from L-Type bidders, then two spectrum blocks are allocated to licensed operations and to the bidders whose bids were among the four highest bids.

A simple example can be used to illustrate the allocation and aggregate bid formation rule. Consistent with the information shown in Figure 4 (which is reproduced as Figure 6 below), suppose the auction has closed and that bidders have truthfully revealed the value they placed on having two blocks of spectrum allocated to either licensed and unlicensed operations.[22] Under these assumptions, the clock auction would generate an outcome in which two blocks of spectrum are assigned to bidders A and B on a licensed basis, and two blocks of spectrum are designated to unlicensed operations.

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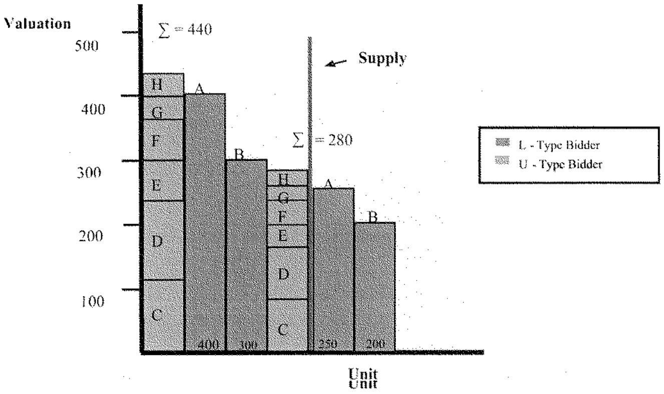
[21] Licensed bidders also submit distinct bids for the first and second units of desired spectrum.

[22] Truthful bidding is assumed here only to illustrate the allocation and pricing rules in the auction mechanism. Later, it will be demonstrated that unlicensed bidders rarely have an incentive to bid completely truthfully.

Figure 6: Session 1 Efficient Assignment

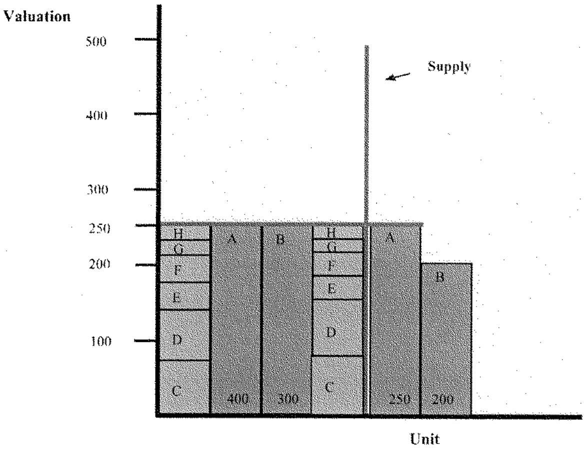


5.2 Pricing Rule

The "public good" aspect of the demand by unlicensed bidders also gives rise to a "threshold" problem, in which U-type bidders must coordinate their bidding strategies in order to reach a favorable outcome. The presence of a threshold problem highlights the importance of establishing a pricing rule that encourages subjects to reveal the value they place on having spectrum allocated to one use type or the other. To that end, because of its favorable incentive properties, all trades in the experimental study occur at a uniform price, where this price is equal to the highest rejected bid. In the above example, because there are four blocks of spectrum up for auction, the highest rejected bid is equal to the fifth highest bid, including U1 and U2. While L-Type bidders pay the highest rejected bid, U-Type subjects that bid in the auction pay a price that is "based on" the highest rejected bid. In particular, U-Type subjects that bid in the auction are assigned a cost that is proportional to the share their bids represented in the aggregate bid.

A simple example can be used to illustrate the above pricing rules. Continuing with the example shown in Figure 6, suppose the auction has closed and that bidders have truthfully revealed the value they placed on having spectrum allocated to licensed and unlicensed operations. As shown in Figure 7, under these conditions Bidders A and B would receive one block of spectrum each, while two blocks of spectrum would be designated to unlicensed operations. Under the auction's pricing rules, all four blocks are sold for a uniform price of 250, which represents the highest rejected bid. In addition, winning U-Type bidders are assigned a cost that is proportional to the share their bids represented in the aggregate bid. For example, consider Bidder C, a U-Type bidder, and its contribution of 120 to the aggregate bid for allocating a single block of spectrum to unlicensed operations. Because Bidder C's bid of 120 represents 27% of the value of the accepted aggregate bid of 440, under the adopted pricing rules Bidder C is required to pay 27% of the final transaction price (i.e., 250), or 68.2. Similarly, because Bidder C's bid of 80 to have a second block of spectrum designated to unlicensed operations represents 29% of the value of the accepted aggregate bid of 280, Bidder C is required to pay 29% of the final transaction price, or 71.4.

Figure 7: Session 1 Pricing Rule



To assist readers in visualizing the proposed clock auction, the authors have created a flash clip that demonstrates the major features of the described auction. The flash clip can be accessed at http://www.fcc.gov/osp/projects/unlicensed.html.

6 The Mechanism Design Problem

6.1 Provision Points and "Free Riding"

There are several reasons why a market may fail to allocate different license regimes to blocks of spectrum in an efficient manner. One general source of market failure is the unwillingness of bidders to reveal the true value they place on a particular license regime.[23] A major cause of under revelation in the current example is free riding behavior involving unlicensed operations. The economics are straightforward. Spectrum designated to unlicensed operations provides an alternative means by which users can access the Internet. Unlicensed use makes it possible for Internet users and entities (e.g., Google, Microsoft, Yahoo) that wish to sell access to such users to advertisers to do so without the possibility of paying a fee to an intermediary (e.g., Verizon, Comcast). Because of the common pool resource nature of spectrum designated to unlicensed use, the benefit that a given firm receives from expending the effort to avoid such a fee extends to every U-Type firm. The ability of a given firm to benefit from the actions of another firm introduces a public good aspect to the economic problem. In the current context, although it is in every U-Type firm's interest to have spectrum designated to unlicensed use, any individual U-Type firm has an incentive to "free ride" off the bids of others bidders in an attempt to maximize its own profits. If a significant number of U-Type firms elect to free ride, then the efficient designation of spectrum to licensed and unlicensed operations may not occur.[24]

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[23] Although not unique to this problem, there are other reasons why a market may "fail." One reason is the existence of non-competitive prices in the retail service market. The price signals generated by a market reflect the willingness of buyers and sellers to complete a trade. If the expressed willingness to trade is the result of competitive forces, the price signals generated in the market will themselves be competitive and will, thus, efficiently allocate resources. One instance where the willingness to trade is too high is when a buyer wishes to acquire an asset, in part, because it wishes to avoid having the asset employed by a competitor. In this instance, the willingness of the buyer to trade, as measured by the value the buyer places on the asset, is inefficiently high. This reasoning points to a possible inefficiency in the use of market forces to guide the licensing rule determination process. In particular, if the value that L-Type bidders place on spectrum is driven largely by the profits they would earn from not having the spectrum in the hands of a competitor, an auction outcome that relies on market prices to guide the licensing rule determination process may not lead to the efficient outcome.

There are several possible solutions to the problem. One solution involves preventing L-Type bidders from participating in the market process. This can be achieved by establishing a spectrum cap that limits the amount of spectrum each licensee may own in a given geographic area. Another approach involves allowing the firm to participate in the market, but discounting the firm's bid by an amount equal to the value the firm places on owning the asset for purely anticompetitive reasons.

[24] Notwithstanding the public good aspect to spectrum acquisition costs for unlicensed bidders, these bidders may also compete with each other for retail customers.

In many public good problems, free riding behavior is a *dominant strategy*.[25] In particular, it is welfare maximizing for the firm or agent to refrain from engaging in behavior that promotes the welfare of the group *independent* of the behavior of the other firms. This is so because the cost of contributing to the welfare of the group always exceeds the private benefit from doing so.[26] In the current public good problem, however, it is not a dominant strategy for any one U-Type firm to always "free-ride" off a U-Type bidder's efforts to have a given band of spectrum allocated to unlicensed use.[27]

One distinguishing feature of the current problem is the existence of a "provision point."[28] A provision point is the minimum aggregate contribution users must collectively make in order for any given user to obtain value from his/her contribution.[29] In the current context, in order for a single block of spectrum to be designated to unlicensed operations, the sum of the bids submitted by U-Type bidders must exceed the lowest bid submitted by the L-Type bidders. This bid represents for U-Type bidders the provision point for that first block of spectrum. Importantly, the provision point represents a Nash equilibrium since any unilateral deviation below the provision point value is unprofitable for the contributors.

The likelihood that an equilibrium without significant free riding will be achieved is increased as a result of the so-called "give back" option at work in the current economic environment. In a typical public good problem, a player's payoff is often reduced by the amount of his/her contribution, independently of whether other parties have made a contribution. In the current example, a contribution by the U-Type bidder only reduces his/her payoff if the sum of the U-Type bids exceeds the provision point. A similar effect is achieved when organizations conduct fund drives under the rule that the public good will not be provided unless a certain minimum level of funding is achieved. By reducing a U-Type bidder's risk of making a contribution, the give back option can be expected to increase the contributions made by such bidders.[30] However, the give back option and provision point features may not always lead to the efficient outcome. Both features give rise to multiple Nash equilibria when participants need contribute only a portion of the value they place on having a public good provided. The existence of multiple equilibria may create an important coordination problem because participants will typically have differing equilibrium preferences.[31] The non-dominance of a pure free–riding behavior and the existence of multiple equilibria can be demonstrated using the parameters included in the Session 1 experimental set-up (reproduced in Table 1 below).

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[25] The classic example of an inefficient dominant strategy equilibrium is the "prisoners' dilemma," in which each prisoner has an incentive to confess even though their combined welfare is maximized if neither confesses.

[26] A variety of experimental studies have shown that even in instances where, according to game theory, free riding behavior is a dominant strategy, individuals fail to behave in such a manner. See Marwell, G., and R. Ames (1979), "Experiments on the Provision of Public Goods: Resources Interest, Group Size, and the Free-Rider Problem," *American Journal of Sociology* 84(6):1335-60, Isaac, M, J. Walker, J., and S. Thomas, "Divergent Evidence on Free Riding: An Experimental Examination of Possible Explanations," *Public Choice* 43(1):113-49.

[27] In this case, the public good problem is more closely related to two other well known game situations. In the game of "chicken" both players want to follow aggressive strategies as long as their opponent is expected to be passive. Nevertheless, the equilibrium outcomes call for only one, but not both of the players to be aggressive. In a somewhat different game known as the "battle of the sexes", one player wishes to attend an event (e.g. a boxing match) and the other player wisher to attend a different event (e.g. a ballet). In spite of these preferences, both players would rather go to the same event rather than different ones. In both "chicken" and "battle of the sexes" there are multiple Nash equilibria, which are welfare superior to the "free riding" equilibrium which also exits in these cases.

[28] The role of a provision point in public good problems is discussed in detail by John Ledyard, "Public Goods: A Survey of Experimental Research," in *Handbook of Experimental Economics*, edited by J. Kagel and A. Roth, Princeton University Press 1995.

[29] Marwell and Ames (1979) were the first to introduce the notion of a provision point in a public good experiment.

6.2 Nash Equilibria

Economic theory predicts that, at a minimum, participants in a mechanism design problem will rationally select bidding strategies that are sustainable as Nash equilibrium outcomes. In the context of a spectrum auction, a Nash equilibrium represents a set of bidding strategies such that no bidder can expect to increase his or her payoff by following a different bidding strategy, assuming that every other bidder continues to play their equilibrium strategy. In the absence of a strictly dominant strategy for each bidder, there can in general be a large number of Nash equilibria. A full description of these equilibria depends on a detailed description of the information available to each bidder about the auction mechanism itself and each bidder's beliefs about the private valuations of all rival bidders. In a set of auction experiments to be described later, experimental subjects were told the rules of the auction and their individual assigned valuations, but were given no information about other subject's valuations other than the total number of subjects participating. Suppose, contrary to this experimental setup, that each bidder has complete information about the number of other bidders, the type (i.e. licensed/unlicensed) of each bidder, and each bidder's true valuation. In the remainder of this section we will show that under these assumptions it is possible to enumerate the full set of Nash equilibrium outcomes.

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[30] Experimental evidence indicates that the "give back" option has the effect of increasing contribution rates in some public good environments. See Isaac, M, D. Schmidtz, and J. Walker (1989) "The Assurance Problem in a Laboratory Market," *Public Choice*, 62, 217-236.

[31] See Isaac, Schmidtz, and Walker (1989) *op cit*.

In the experiments, the auction was conducted as a particular type of "clock auction" as described above. The tested clock auction can be shown to be strategically equivalent to a sealed bid auction in which each bidder submits two bids – one for the first unit of spectrum acquired and a different bid for the second unit. In the experimental set up, the clock price started at 10 and advanced in units of 10. In order to simplify the present analysis it will be assumed that bids can be submitted in any integer units, so that the minimum bid increment is equal to 1. As in the experiment, the market clearing price is equal to either the highest rejected bid for licensed use or the highest rejected aggregate bid for unlicensed use, whichever is the highest. Winning licensed bidders pay this price, while each winning unlicensed bidder pays an amount proportional to his actual bid, such that the sum of the unlicensed prices add up to the market clearing price. The values assigned in Session 1 of the experiments are shown in Figure 2 above and Table 1 below.

Table 1: Assigned Valuations in Session 1 of the Experiment

Bidder	Subject Type (L/U)	Value Unit 1	Value Unit 2
A	L	400	250
B	L	300	200
C	U	120	80
D	U	120	80
E	U	60	40
F	U	60	40
G	U	40	20
H	U	40	20
Sum C – H		440	280

Assuming complete information, there are a large number of Nash equilibria in the auction game, one of which is shown in Table 2. In this equilibrium, licensed bidders submit winning bids for three of the four licenses, and the remaining block of spectrum is awarded to unlicensed bidders collectively. The market price is determined by the highest rejected bid, which in this case is made by both licensed bidder B and collectively by unlicensed bidders C through H.[32]

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[32] We will demonstrate later that the efficient allocation cannot be sustained as a Nash equilibrium if all bidders bid their true values. However, it will also be shown that the efficient allocation can be sustained as an equilibrium with different bidding strategies.

Table 2: An Example of Nash Equilibrium

Bidder	Bid 1	Bid 2	Price	Surplus
A	400	250	200	250
B	300	200	200	100
C	56	55	55.72	64.28
D	55	55	54.73	65.27
E	27	27	26.87	33.13
F	27	27	26.87	33.13
G	18	18	17.91	22.09
H	18	18	17.91	22.09
Sum C – H	201	200	200	240

To verify that the bidding strategies shown in Table 2 represent a Nash equilibrium, one needs to show that no bidder can unilaterally benefit by changing either one of its bids. Given the bids in Table 2, bidder A wins 2 units; bidder B wins 1 unit; and the unlicensed bidders together win 1 unit. Bidder B's bid for a second unit and the combined bids of bidders C – H for a second unit tie as extra-marginal (rejected) bids equal to 200. These bids establish the market clearing price. No winning bidder can gain by either increasing its bid for the *first* unit of spectrum (since it is already winning and the market price is determined by the tie bids for a *second* unit of spectrum) or reducing his/her bid for that unit (since each bidder gets positive surplus for each unit won, and reducing a bid can only result in the loss of that surplus). If bidder B increases its bid for the second unit to 202 or greater, it will become a winning bidder, but it will have bid above its true valuation, and will therefore be worse off.[33] Since bidder B's second bid is tied with the second aggregate bid of C – H, bidder B cannot change the market price by reducing its bid for a second unit of spectrum, and therefore cannot increase the surplus attained for the first unit.

None of the unlicensed bidders C – H can benefit by unilaterally reducing their bid for the *first* unit of spectrum, since doing so would convert their collective bid into a losing bid (or tie for losing) which would result in forfeiting the surplus each bidder obtains. Similarly, none of the unlicensed bidders C – H can benefit by unilaterally increasing their bid for a *second* unit of spectrum. In order to displace bidder A's winning bid for a second unit and, in so doing, obtain a second block of spectrum for unlicensed designation, the unlicensed bidders must increase their aggregate bid to 251 or more. Such a bid would increase the market clearing price to 250, thereby reducing by 50 the surplus that any individual bidder obtains on their first block of spectrum. This reduction in surplus exceeds the 30 units of surplus (i.e., 280 – 250) such bidders collectively would obtain from having a second block of spectrum designated to unlicensed operations.

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[33] If B bids 201 for a second unit it will win with a 50% probability assuming that ties are settled by a coin toss, and this will also result in a loss of surplus.

There are a large number of Nash equilibria for the auction game described in Table 1. These equilibria can be sorted into three different "Types" according to the number of blocks of spectrum which are won collectively by the unlicensed bidders. A "Type 1" equilibrium, as represented in Table 2, results in three blocks of spectrum being designated to licensed operations and one block to unlicensed operations. While their quantitative bids may differ significantly, all Type 1 equilibrium strategies have the following characteristics.

1. Bidder A bids an amount for both units 1 and 2 of spectrum that is large enough such that no unlicensed bidder has an incentive to raise his/her bid for a second unit.
2. Bidder B bids an amount for the first unit that is large enough such that no unlicensed bidder has an incentive to raise his/her bid for a second unit. Bidder B bids exactly 200 for the second unit.
3. The six unlicensed bidders place bids for a first unit that sum to exactly 201, and bids for a second unit that sum to exactly 200. [34]
4. Total surplus for licensed bidders A and B is 250 and 100 respectively. Collective total surplus for bidders C through H is equal to 240.
5. Auction revenue is equal to 800 (i.e., 4 x 200).
6. Total surplus is equal to 1390.

In a Type 2 Nash equilibrium, the two licensed bidders win all four blocks of available spectrum. In this case, each of the unlicensed bidders individually attempts to free ride, with the result that no spectrum is allocated to their use in spite of their high collective value for it. Suppose, for example, that each unlicensed bidder places a bid equal to zero. The licensed bidders could then place any bids greater than or equal to 120 (the highest valuation of an unlicensed bidder for a unit of spectrum) for both units of spectrum that they desire. In this case, the market price would be equal to zero, and no licensed or unlicensed bidder could unilaterally increase their surplus by changing their bid. As in the case of Type 1 equilibria, there are an large number of Type 2 equilibria, which all have the following characteristics.

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[34] Since bidder B and the unlicensed bidders C – H both win one unit of spectrum, the market price is determined by the higher of their bids for the second unit. If these bids are not identical, then the bidder placing the higher bid would prefer to reduce that bid by a small amount in order to reduce the market price. If these bids are equal and less than 200, it follows that any unlicensed bidder could have increased surplus by reducing its bid for their first unit of spectrum, and bidder B could also benefit by increasing her bid for the second unit to any amount less than 200. The smallest possible equilibrium bids by A and B in an equilibrium depend on the particular equilibrium bids of C – H for the second unit. If bidders C – H bid as shown in Table 2, then a simple algebraic argument shows each of these bids must be greater than 225 in order to prevent the highest value unlicensed bidders (C and D) from unilaterally increasing their bids in order to gain a second unit of spectrum for unlicensed use.

1. Bidders C – H collectively bid an amount less that 200 (bidder B's value for a second unit of spectrum) for each unit of spectrum. The losing bid for the first unit of spectrum determines the market price.
2. Bidders A and B bid an amount for both units of spectrum that is high enough to make it unprofitable for an unlicensed bidder to bid for a second unit.
3. Total surplus for licensed bidder A is 650 minus twice the market price, while total surplus for bidder B is 500 minus twice the market price. Collective total surplus for bidders C through H is equal to 0.
4. Auction revenue is equal to the highest collective bid of C – H multiplied by 4.
5. Total surplus is equal to 1150.

Finally, there exist Type 3 Nash equilibria which sustain the efficient allocation. That is, the two licensed bidders each win one block of spectrum, and two blocks of spectrum are designated to unlicensed operations. Unlike Type 1 and Type 2 equilibria, Type 3 equilibria *require* that some bidders bid above their true valuations.[35] As an example, suppose that bidders A and B bid their true valuations for the first unit of spectrum, and that both bid 250 for the second unit of spectrum, which is equal to A's true value and greater than B's true value. Suppose in addition that the unlicensed bidders collectively bid 251 for both units of spectrum, with each bidder bidding less than or equal to his or her value.[36] Given these bids, neither A nor B would want to increase their bid for a second unit to an amount greater than 251, since doing so would result in winning at a market price greater than either bidder's value. Similarly, neither A nor B can benefit by unilaterally reducing their bid for a second unit, since doing so would not change the market price. While these bids formally represent a Nash equilibrium, we note that we can find no compelling reason to believe that bidders A and B would choose to place bids for a second unit of spectrum in this manner.[37]

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[35] Suppose that unlicensed bidders C through H place winning bids for two units of spectrum and that the remaining two units are both won by licensed bidder A at bids less than or equal to A's true value. Then bidder B must have placed bids such that the market price is less than or equal to 250 (bidder A's value for the second unit). It then follows that the collective bids of C – H for both winning units must also be less than or equal to 251, since individually each bidder has an incentive to reduce its bid in order to reduce its share of the market price as long is the collective bid is still winning. But now, bidder B would prefer to increase its bid for the first unit to any amount greater than 251, which would allow B to win that unit at a market price that would remain less than or equal to 251.

Now suppose that bidders A and B each win exactly one unit of spectrum. In this case, A and B must place identical bids for their second unit of spectrum, since otherwise, the bidder placing the higher bid would prefer to lower that bid in order to reduce the market price (and increase the surplus on the winning bid for the first unit of spectrum). If all bids are less than or equal to true values, the resulting market price must be less than or equal to 200. As before, the unlicensed bidders must collectively bid an amount less than or equal to 201. In this case, bidder A would prefer to increase its bid to anything greater than 201, which would allow it to win a second unit at a market price less than or equal to 201.

All Type 3 equilibria have the following characteristics.

1. Bidders A and B bid any amount greater than 250 for the first unit of spectrum.
2. Bidders A and B place identical bids less than or equal to 250 for the second unit of spectrum. These bids determine the market price.
3. Bidders C through H collectively bid any amount greater than 250 for both units of spectrum.
4. Total surplus for bidder A is 400 minus the market price and for bidder B is 300 minus the market price. Collective total surplus for bidders C – H is equal to 720 minus twice the market price.
5. Auction revenue is equal to the market price multiplied by 4.
6. Total surplus is equal to 1420.

While each type of equilibrium permits a large number of equilibrium bidding strategies, the total surplus and the surplus for each bidder depend only on the bids of the extra-marginal bidders which determine the market price. These results are summarized in Table 4.

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[36] This is possible since the values for the second unit sum to 280.

[37] It can be demonstrated that any strategy in which a player bids above her value is weakly dominated by an alternative strategy in which the bid is equal to the value. Weakly dominated strategies cannot be eliminated as equilibrium outcomes, but they are in some cases rejected by a process of iterative elimination of dominated strategies.

Table 4: Summary Results of Nash Equiliria for Session 1 Valuations

	Market Price (P)	A Surplus	B Surplus	C – H Surplus	Total Surplus
Type 1	200	250	100	240	1390
Type 2	P < 200	650 – 2 P	500 – 2 P	0	1150
Type 3	P ≥ 250	400 – P	300 – P	720 – 2 P	1420

Given the substantial difference in total surplus across the three equilibrium types, an important question is which equilibrium type market participants will settle on. Note that licensed bidders A and B unambiguously prefer Type 2 equilibria while unlicensed bidders C – H unambiguously prefer Type 1 equilibria.[38] Nevertheless, game theory does not shed light on which type of equilibrium is most likely. In the following section we examine the equilibrium outcomes selected by market participants in two different experimental environments.

7 Economic Experiments

A series of 34 separate auction experiments were conducted, 13 of which were conducted under the Session One valuation set, while 21 were conducted under the Session Two valuation set. The information that subjects had regarding the economic environment was limited. Each of the subjects knew their own valuations, the total number of subjects in the experiment, the total number of available blocks of spectrum and that each subject had a demand for exactly two blocks. Subjects were unaware of the number of participants that preferred licensed versus unlicensed use, as well as the value each subject placed on having one or two blocks of spectrum designated to a given license regime.

To induce behavior reminiscent of the naturally occurring environment, subjects earned profits based on their performance in the experiment. In particular, subjects were paid an amount that is equal to the difference between the value they placed on having spectrum allocated to their preferred use minus the price they paid to access spectrum on that basis. Therefore, continuing the example of section 5.2 (which assumes truthful bidding), Bidder C would earn 51.8 (i.e., 120-68.2) from having one block of spectrum designated to unlicensed operations, and would earn an additional 8.6 (i.e., 80 – 71.4) from having a second block of spectrum allocated to unlicensed operations. Importantly, in the experimental framework, a U-Type bidder has the option to bid less than his or her value, or even to not submit a bid in the auction, deciding instead to simply free-ride off the bids submitted by other U-Type bidders. In such a circumstance, if the spectrum is allocated to unlicensed operations, the bidder is not allocated a cost share and thus, earns an amount equal to his/her assigned valuation for that spectrum block.

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[38] No bidder prefers a Type 3 equilibrium. Auction revenue and total surplus are highest in this type.

The experimental results reveal that the Type 1 equilibria are approximately attained in a large number of experimental sessions. In one session, the final experimental bids are shown in Table 5 along with the prices paid and surplus earned by each subject. While the unlicensed bidders somewhat overbid for the first unit of spectrum, by collectively bidding 260 instead of 201, in all other respects, the experimental bidding conforms exactly to a Type 1 equilibrium.

Table 5: Bids Submitted in Session 1 of the Experiment

Bidder	Bid 1	Bid 2	Price	Surplus
A	460	240	200	250
B	300	200	200	100
C	80	80	61.54	58.46
D	100	60	76.92	43.08
E	20	20	15.38	44.62
F	10	10	7.69	52.31
G	20	10	15.38	24.62
H	30	20	23.08	16.92
Sum C – H	260	200	200	240

Summary results for all experimental sessions are shown in Table 6. These results show that Type 1 equilibria were obtained in the vast majority of experimental auctions. For example, in 28 of the 34 auctions (i.e., 82%), the competitive process resulted in one spectrum block being designated to unlicensed use. In comparison, in only two out of the 34 auctions (i.e., 6%) did the competitive process lead to all four blocks being designated to licensed operations (Type 2 equilibria). Finally, in four out of the 34 auctions (i.e., 12%), two spectrum blocks were designated to unlicensed use, which was the efficient allocation.

Consistent with the observation that Session 2 valuations presented a greater coordination challenge for U-Type bidders than Session 1 valuations, U-Type bidders were always able to coordinate their bids in the Session 1 valuation environment so that at least one block of spectrum was allocated to unlicensed operations. In contrast, there were two instances in which U-Type bidders were unable to coordinate their bids under the Session 2 valuation environment so that no blocks were allocated to unlicensed operations.

Table 6: Experimental Results

	Average Efficiency	Number of Blocks Designated to Unlicensed Operations (Efficiency)			Total Number of Auctions
		0 Blocks	1 Block	2 Blocks	
Session 1	0.95	0 (.82)	11 (.98)	2 (1.0)	13
Session 2	0.95	2 (.80)	17 (.99)	2 (1.0)	21

The inability of the mechanism to achieve a higher efficiency value is due, in part, to the incentive U-Type bidders have to strategically reduce their demands for the second block of spectrum. It is well known that in instances where bidders have multi-unit demands and a simultaneous ascending-bid auction with uniform pricing is employed to allocate items, bidders can find it in their mutual interest to reduce demand in an effort to maximize their profits.[39] Such "demand reduction" would be profitable if the gain from a lower price for the buyer's "n"-infra-marginal units is greater than the profit it would earn from "n+1" infra-marginal units. In the current example, U-Type bidders would earn greater profits if they collectively failed to bid for a second block of spectrum electing, instead, to have the market generate a lower market clearing price.

The average efficiency obtained under each session valuation environment was 95%. In evaluating the performance of the market, it is important to recognize that the lower bound for the assignment efficiency is the level of efficiency obtained when zero blocks of spectrum are assigned to unlicensed operations. As shown, the efficiency of the market when zero blocks of spectrum are assigned to unlicensed operations is 82% under Session 1, and 80% under Session 2.

8 Concluding Comments

One of the more important spectrum management problems the FCC faces involves whether to designate spectrum to either licensed use or unlicensed operations. Spectrum designated to unlicensed use is made freely available for uses which comply with appropriate technical standards. Spectrum allocated to licensed use grants the owner of the license the right to exclude non-payers from using the spectrum and is generally awarded to private parties through an auction mechanism. The FCC and other regulatory bodies attempt to solve this problem through an administrative process. However, such a process has some important limitations, not the least of which is that it often is based on the reported needs of interested parties. One method of reducing the incentive that parties have to exaggerate the value they place on a given set of license rules involves creating a market for such rules in which participants bid to have their license rule needs met. By reducing the incentive that interested parties have to misrepresent their economic interests, this approach may substantially improve the efficiency of the licensing process.

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[39] Such an effect is referred to as strategic demand reduction. For a discussion of strategic demand reduction in FCC spectrum auctions, see Weber, Robert, (1997) "Making More With Less." *Journal of Economics and Management Strategy*, Vol. 6, pgs. 529-548.

We examine the feasibility of using a market mechanism (i.e., a "clock auction") to determine, based on the bids submitted by market participants for the corresponding licensing rules, the efficient allocation of a given amount of spectrum between licensed and unlicensed operations. One general source of market failure is the unwillingness of bidders to reveal the true value they place on a particular license regime. A major cause of under revelation in the current instance is "free riding" behavior involving unlicensed operations. If a significant number of bidders that wish to see spectrum designated to unlicensed operations free ride on the bids made by other similarly-interested bidders, then the efficient designation of spectrum to licensed and unlicensed operations may not occur.

This study created an economic model that was designed to stress test whether our market approach could achieve the efficient assignment of license rules to four spectrum blocks. Assuming complete information, analyses demonstrate that there are a large number of Nash equilibria in the auction game. Economic experiments were conducted to determine whether bidders had a tendency to settle on equilibria that achieve the efficient designation of spectrum to licensed and unlicensed operations. The results of the experiments show that in 28 of the 34 auctions, the competitive process resulted in one spectrum block being designated to unlicensed operations. In addition, in four of the 34 auctions (i.e., 12%), two spectrum blocks were designated to unlicensed use, which was the efficient designation. The inability of the market mechanism to achieve a higher efficiency value is due, in part, to the incentive U-Type bidders have to strategically reduce their demands for the second block of spectrum. Indeed, in the current example, U-Type bidders would earn greater profits if they collectively failed to bid for a second block of spectrum electing, instead, to have the market generate a lower market clearing price.

Mr. SHIMKUS. While I do that—my question will go to Mr. Guttman-McCabe—what do you think of the unlicensed provisions in the Republican staff draft which are based upon the document I just entered in the record?

If a coalition advocating unlicensed use cannot outbid a single wireless carrier for a particular band or spectrum, doesn't that suggest the particular spectrum is more useful for licensed services? If the particular spectrum is better suited to unlicensed use, as in Mr. Calabrese's—your opening statement kind of addressed this—wouldn't the people who support that be able to pull enough capital to free that up? And this goes into my opening comment. The debt is the threat, and isn't spectrum too valuable to give away for free, especially in this economy?

Mr. GUTTMAN-MCCABE. Thank you, Congressman.

This is an extraordinarily difficult question and issue. At CTIA, we believe unlicensed needs to be part of the solution. It currently is part of the solution, and we look at it. Yet if I take off my CTIA hat and I put on my economist hat, which is what I was for half a dozen years before I went to law school, I recognize the conflict of societal good being auctioned on one hand and being given away on another hand.

And I think that issue is further complicated when you look at incentive auctions and that the incentive auction and the prices that are brought from those auctions, from the licensed bidders, would be used to clear spectrum that would then be given to other companies. So it becomes incredibly complicated once you begin, from an economics, perspective to look at that.

I think we need to at least consider what other mechanisms are out there, recognizing—obviously, absolutely recognizing the importance of unlicensed. So we are looking at the discussion draft from the chairman. But it is a complicated issue.

Mr. SHIMKUS. It is. And I am pretty intrigued by it, because I do think you get the benefits of both. You do get the free use to be able to go in places where it is not there but at a return.

I am going to end, because my time is fastly ending here, and just again highlight to my friends in public safety that one of the things that Congresswoman Eshoo and I are trying to do is understand that, as we go to new technologies, there is going to be a cost, and I would submit that what Anna and I are doing is to make sure we have the ability to help you get there.

Now, where Anna and I disagree is that I think we do that by auctioning and getting money, with your friends behind you. We have had these discussions before. And that is where we really want to get to, is the financial considerations.

With that, I yield back my time.

Mr. WALDEN. I thank the gentleman.

Obviously, putting this unlicensed spectrum issue in the bill brings it to the floor, and we can have this debate and discussion and find out what the best course of action is.

I turn now to the gentleman from California, Mr. Waxman, for 5 minutes.

Mr. WAXMAN. Thank you very much, Mr. Chairman.

Mr. Moore, I was taken by surprise by one of the statements you made. It caught my attention. You said that, if passed into law as currently written, the Republican draft would leave public safety worse off than it is today. That is alarming. Because our primary goal is to address the difficult problem of making an interoperable nationwide broadband national communications network a reality, and the last thing any Member wants is to make things worse.

Can you explain this concern in more detail? How would the Republican discussion draft make things worse than it is today for public safety?

Mr. MOORE. Certainly, Congressman. Thank you, Congressman. I thought I was beyond the day that I could surprise any member of Congress, but I appreciate that.

It is not my intention to alarm anybody with the statement other than to say a couple of things.

Number one, as the proposed majority draft reads, it talks about suspending any future 700 narrow band deployments. There are a number of jurisdictions around this country, their existing land mobile radio systems are end-of-life today, and they need to be refreshed, and they are in the process of doing that.

We cannot basically stop those processes now. That would be the equivalent of saying to large swaths of our country, we can't protect you. That is not going to happen. I just can't see that. And I don't think that is the intent of the draft. So, again, without much discussion with the membership to talk about that, I think we would find ourselves in a difficult spot.

We also do believe that auctioning the D-block will make us less safe. Now, current law does say that. We acknowledge that. But we believe definitely if we move forward and stop all deployments—planned deployments of 700 in the narrow band in the short term, it will make America less safe.

Mr. WAXMAN. Do you have any specific thoughts about how the draft might be modified to address your concern?

Mr. MOORE. I think there are a couple of things. Obviously, reallocate the D-block to public safety, which would be extremely helpful, and we would be grateful.

Mr. WAXMAN. That comment did not take me by surprise.

Mr. MOORE. But, also, the notion that the current 700 systems that exist today and those that are in the pipeline are critical to keeping us safe today. And the reality is it may be 10 years, 12 years down the line that we may be able to migrate some of those to broadband, but that is not today, and that is not in the near term.

Mr. WAXMAN. Dr. Cramton, in your testimony you emphasize that Congress should focus on basic principles in enacting legislation to authorize incentive auctions. You say the easiest mistake Congress can make is to prevent the FCC from adopting the best auction design by including auction details and other restrictions in the enabling legislation. This is consistent with what we have heard from other economists that have testified before this subcommittee and was the central message in the 112 economists' letter sent to President Obama.

How do you balance your suggestion with broadcaster concerns about the structure and shape of the auction? You want Congress to list principles, but the broadcasters want specific protections. Do you think there is a middle ground we can all agree on and do either of the discussion drafts get there?

Mr. CRAMTON. Well, I hope there is a middle ground, but I do think that you have to be very careful in thinking about all these issues. There are a lot of things that interact in the auction design, so I do think that there are—in addition to the broad principles, one could introduce in the legislation assurances—basic features that assure the major stakeholders that they will be treated fairly. So that can be done.

A lot of it are intricate details, such as one thing that really protects people in an auction are bid deposits to make the bids binding commitments. That is very important in an auction. That sort of detail is clearly left for—the setting of bid deposits is left set by the expert. However, the provision for these kinds of instruments to be put in place in the final rule is I think the sort of thing that the stakeholders are looking for. And that can be done. It is a delicate business.

Mr. WAXMAN. Let me ask one of the stakeholders. Senator Smith, how do you respond?

Mr. SMITH. Well, Mr. Chairman, it just really is important to us that, as you balance the public safety component, that the first informers not lose their business model. What that means is the contours. And if the FCC is unfettered and able to move contours as they will, you are affecting 40 percent of the TV stations across this country. There will be blackouts. There will be people left out.

We think if you can protect our contours, there will still be those who volunteer, there will be spectrum available, but you won't damage in a permanent way an industry that many Americans, a rising number of Americans but particularly disadvantaged Americans, economically disadvantaged Americans, will not be denied free over-the-air television.

Mr. WAXMAN. Thank you.

Thank you, Mr. Chairman. My time has expired.

Mr. WALDEN. I thank the gentleman.

I now recognize the gentleman from Ohio, who was here when the gavel fell, apparently, Mr. Latta, for five.

I would just tell our members, too, that they anticipate votes on the House floor sometime to be called between 10:45 and 11:00 and that we would not walk off the floor until 1:30, which makes it really unlikely we would resume this hearing. So to the extent we can move through the questions, that is the latest news.

Mr. LATTA. Well, thank you, Mr. Chairman; and again thanks for our panel for being with us today.

I am a true believer in the incentive auctions, especially within the bill. I have a piece of legislation out there to auction on the spectrum.

But I do find it interesting, especially in Senator Smith's opening remarks, I think everyone out there, when you have to say “truly voluntary”—and I put that in quotation marks—I think there is some mistrust for some reason around Washington that things that are voluntary aren't truly voluntary. That is why I think it is very, very important that we make sure that it is truly voluntary and we don't have to put those quotation marks around what we want to do around this place.

If I could, moving right along, on page 3, Mr. Cramton, of your testimony, you cite that there are three good features of the draft legislation that are worth mentioning; and you go on to say that the draft does not impose restrictions on which broadcasters can participate in the auction. Restrictions of this form would destroy competition in the reverse auction among broadcasters.

Can you expound a bit upon how the reverse auction work will work under the incentive auctions provided under the bill?

Mr. CRAMTON. Sure. Essentially, it is a two-sided auction, so we need competition on both sides. One important aspect of the competition is on the supply side, from the broadcasters.

So you come to a market like Washington, D.C. There is lots of different over-the-air broadcasters in Washington, D.C. They are put a simple question: You can stay on the air as is; you can turn over, say, half your spectrum, share with another; or you can completely shut down your over-the-air business. Now, we need to have competition among those broadcasters in order to get a competitive price for the willingness to relinquish spectrum. Otherwise, they could exercise market power.

We need the same thing on the demand side coming from the operators. This is why the competition and things like interoperability are really important. Because, right now, the industry has been moving towards a duopoly on the demand side, with the two dominant carriers commanding over 90 percent of the earnings in the industry right now. The small players, the regional players, and the smaller national players play a very important role in creating the competition that creates the auction revenues on the demand side.

Now, if we have got the competition on both sides of the auction, what that does is creates an enormous amount of value for the taxpayer and for society at large. So that is the goal, and that is why you have to be very careful with any provisions that you introduce, make sure that the provision is pro-competitive, rather than otherwise. Sometimes these things are subtle.

Mr. LATTA. Again, how do you think this is going to affect the revenue that the auction might produce? And, again, what is your estimate for what that might bring in?

Mr. CRAMTON. Well, I can tell you that the demand is exploding on the demand side. So this is a few years off. It would take 2 years—even if you pass legislation today, it would take probably 2 years to line everything up and make it happen. By then, there is going to be much, much more demand than there is now as people discover the wonderful, amazing things that these phones can do. And as a result—and it is not just phones. It is tablets, everything.

So, as a result, I am quite confident that it will command a very high price. That is what we are seeing in auctions around the world for the 4–G spectrum. I have been involved in many of the auctions in Europe and continue to be involved in those, and other countries are talking about them now as well. And the amounts the bidders are putting on the table, even in countries much, much smaller than the United States, are in billions.

So I have to believe that this spectrum is going to be worth—if there is competition on both the supply side and the demand side, it is going to be worth tens of billions and possibly much, much more. That is very important, especially given the debt problems that we are facing in our economy right now.

Mr. LATTA. Thank you very much.

Mr. Chairman, in the interest of time, I will yield back.

Mr. WALDEN. I thank the gentleman for yielding back.

I turn now to Ms. Matsui from California for five.

Ms. MATSUI. Thank you, Mr. Chairman; and I would also like to thank the witnesses for being here today.

I strongly support preserving unlicensed spectrum for American innovators, and an auction I believe will put American innovators and American innovation at a competitive disadvantage. I recently introduced legislation that will allocate additional spectrum at 5 gigahertz to spur innovation and support the growing demand for Wi-Fi in this country. I thank the Ranking Members Waxman and Eshoo for including this proposal in their draft, and I look forward to working in a bipartisan manner on this moving forward.

Mr. Guttman-McCabe, if the 5 gigahertz spectrum identified by the Republican draft were made available for auction, do you think there would be more than one wireless carrier bidding on it and how much revenue do you think auctioning this spectrum would generate?

Mr. GUTTMAN-MCCABE. Congresswoman, I think when you look at spectrum above 5 gigahertz, our carrier licensees wouldn't likely participate, because it is outside the sweet spot for mobility. So getting it up above 3 gigahertz is something that puts it sort of outside the technology scope right now.

The upside is it could be used for unlicensed, which, as I said earlier, is and will be part of the solution to moving data through our networks.

Ms. MATSUI. OK. Mr. Calabrese, what would the impact of American innovation be if the unlicensed spectrum were to be auctioned off?

Mr. CALABRESE. As I mentioned earlier, I think it would be really a terrible blow when you look at all the things we have done with Wi-Fi, which nobody expected. When this was allocated for unlicensed, it was known as the junk band, because it was just for toys and baby monitors and things where the transaction costs were too high to have people go and get a license or buy a subscription. Then Wi-Fi grew up, and now we have—what is rolling out now is super Wi-Fi on the TV white space channels.

There is already talk—Ericsson, for example, has estimated that the Internet of things will be 50 billion devices by the end of the decade, almost all of that unlicensed. So there is just going to be tremendous innovation fueled that we can't afford to sacrifice.

I wish Mr. Shimkus were still here, because one response I would have to his point—and I think it was made otherwise—well, gee, shouldn't we collect some money from companies that use unlicensed spectrum in creative ways? Of course, almost every workplace, every home, every business is using unlicensed spectrum, and that would be difficult.

But even the ones that are most innovative at using it, if you are going to do that, don't do it at the front end in a one-time auction, because—for all the reasons in my testimony, the free rider problem, et cetera, that is not going to work. I mean, if you really need money that badly, you can always put a device certification fee. There could be 20 cents on every chip or device that is certified for unlicensed. There are billions of them out there. But an auction is the worst idea.

Ms. MATSUI. Thank you.

On the idea of governance, there is billions of dollars at stake in public funding and the safety of life and property at sake, and I think there is a wide agreement that governance is the absolute key to the success of the public safety broadband network. So there must be a national governance standard that ensures the primary goal of achieving a nationwide level of interoperability for the Nation's first responders who are exercising the fiscal responsibility and technical and operational expertise demanded of this national asset.

Mr. Moore, as an initial matter, please explain why you believe a national governance model is key to the success of this network and also why you might believe that our governance model might be better, and it is modeled on the S. 911. And I will say right up front, I don't believe that the Republican draft provides the right type of governance for a project of this scope, complexity, and national importance.

I will let you answer the question.

Mr. MOORE. Thank you, Congresswoman.

We do believe that a national governance piece is critical to making sure that this is deployed on a nationwide level.

I will say this, though, that our vision would be, from a public safety standpoint and from the State and local government, is there needs to be local control and input into that governance. That has got to be a key piece. Hence, the number of seats on that particular board needs to be there so that we have the requisite input.

But the truth of the matter is when you are talking tens of billions of dollars and you are talking about making sure that standards are set on a nationwide level, you do need that nationwide presence, and we do believe, based on our experience locally, the model that is in the Democratic draft bill is what we would support. And the same thing, it mirrors S. 911.

Ms. MATSUI. Thank you.

Mr. WALDEN. I now recognize the gentlewoman from Tennessee, who will be I think our last questioner, because they called the votes. There are 18 of them. We will go to Mrs. Blackburn.

Mrs. BLACKBURN. Thank you, Mr. Chairman.

I promise that I will give you all the opportunity to submit in writing any further detail in the questions, but I do want to get a couple of things out here.

Mr. Guttman-McCabe, to you first. The draft doesn't call for any delineated timeline in these auctions except to say within 10 years and then within 5 years. As we go through this discussion draft, do you think we need more clarity, should there be more delineation, and how will it help the market? And do you think that if we were to more clearly delineate the schedule, would it have a positive or negative effect on the Treasury?

Mr. GUTTMAN-MCCABE. Thank you, Congresswoman.

I think the clearer you can be, the better. To the extent that you are recognizing and trying to derive benefits to the budget and scoring, we understand that. But front loading this rather than back loading it will be better. Having a timeframe laid out as to when spectrum will come to market will be better. It will help our carriers, who will have to spend billions.

Mrs. BLACKBURN. Let me interrupt you there, because I know there may be a couple of other questions that want to come in.

Dr. Cramton, I want to bring you in on this discussion. The Upton-Walden draft precludes the FCC from imposing conditions. Waxman-Eshoo does not. I want to hear from each of you about what you think conditions will do to these auctions.

We have had all these net-neutrality discussions. Professor Cramton, I have to tell you, it looks like you were against it before you were for it, or for it before you were against it. I have got your July '07 and your February '11 paper, and you take both sides of the issue when it comes to net neutrality and how you think it would affect the auction. So I think a little bit of clarification—do you still think that net neutrality conditions will increase revenues received from the auctions? That is what you laid out in your '07 paper. So you have been on both sides of that issue.

Mr. Guttman-McCabe, I want to hear from you about the conditions and what you think. So very briefly.

Mr. CRAMTON. Very briefly, respectfully, I haven't been on both sides of the issue. Net neutrality, I have actually tried to stay away from that. In fact, the C-block in '07, the issue was not net neutrality. It was open access. And I was a big fan of open access at the time, and the bidders were big fans of open access at the time.

Mrs. BLACKBURN. OK, let me then interrupt you and ask you to submit in writing some clarification. If you want to go back and look at these two papers and then provide us some clarity, I think that might help in informing the record.

Mr. GUTTMAN-MCCABE. Dr. Cramton has mentioned numerous times—and I agree completely—about the need to drive competition in the bidding, and we fully support that. We are concerned that adding encumbrances will do the exact opposite.

Dr. Cramton suggested that the bidders like the open access requirement. The reality is there were two bidders on that license. If you go immediately next door to the other license, there were 50, 60, 70 bidders. A bigger license with an encumbrance went for half the price.

The most stark illustration is Los Angeles without the encumbrance—Los Angeles without the encumbrance sold for significantly more than the entire West Coast with the encumbrance, and the West Coast license was twice as big. So the non-encumbered license drew multiple competing bids.

Mrs. BLACKBURN. Senator Smith, I just can't get let you go without asking you a question today. You mentioned the DTB chip, and I think it was last month at a hearing that one of your broadcasters raised a similar issue. So is NAB seeking a technology mandate that all mobile phones carry a mobile DTB chip?

Mr. SMITH. No, we are not seeking a mandate.

Mrs. BLACKBURN. You are not seeking a mandate. I thank you for the clarification.

I yield back.

Mr. WALDEN. The gentlelady yields back her time.

I turn now to the distinguished gentleman from Michigan, Mr. Dingell, for 5 minutes.

Mr. DINGELL. Mr. Chairman, you are most courteous; and I thank you.

To Senator Smith, these will be yes or no questions.

Is it your understanding that the Federal Communication Commission's national broadband plan recommends reallocating the 120 megahertz of broadcast television frequencies for wireless broadband access? Yes or no?

Mr. SMITH. Yes.

Mr. DINGELL. Now, again, Senator, it is also true that the NAB has expressed grave reservations about granting the Commission unfettered authority to reclaim this much spectrum for fear of unfair treatment to broadcasters, is that correct?

Mr. SMITH. Yes, that is correct.

Mr. DINGELL. Now, is it your understanding—well, let me say this. Detroit is the 10th-largest broadcast market in the country. It has 14 stations licensed in its DMA. Now, is it your understanding that if the Canadian channel reservations are taken into account and the FCC moves ahead with its goal of reallocating the 120 megahertz of broadcast spectrum, there will be no channels available for any of Detroit's 14 stations? Yes or no?

Mr. SMITH. Yes.

Mr. DINGELL. Now, Senator, so you are telling me that, absent stringent protection for broadcasters and explicit limitations on the FCC to conduct incentive auctions, my people in Detroit won't be able to get free over-the-air broadcasting?

Mr. SMITH. Not just your people, Congressman, on the northern tier but also those members on the southern tier, similar treaties with Mexico.

Mr. DINGELL. Every border city has the potential of having that problem.

Mr. SMITH. Of having no broadcast television.

Mr. DINGELL. And that would also potentially include things like Cuba?

Mr. SMITH. Absolutely.

Mr. DINGELL. Now, it is also true that American DMAs along the Canadian and Mexican border will suffer similar reductions. We have already addressed that, and you agreed.

Now, I have asked the FCC for all of these answers to the questions I have raised and haven't gotten a satisfactory answer. Absent compelling national security related concern, have you heard of a Federal agency not answering a congressional request for information? Yes or no.

Mr. SMITH. Congressman, in 12 years in the U.S. Senate, they always answered; and the House of Representatives is an equal body to the United States Senate.

Mr. DINGELL. I am going to try and see that they are pounded about the head and shoulders until they come forward with these answers.

Now, do you think my skepticism about granting the Commission limitless authority to conduct incentive actions is justifiable?

Mr. SMITH. Well, we are for incentive auctions. We believe there are reasonable protections to preserve broadcast as we promote broadband——

Mr. DINGELL. Remember, my time is running.

Mr. SMITH. If we don't do that, America will regret; and your phones will light up as few things do when you affect people's TVs.

Mr. DINGELL. This is a question about NAB support. Does the NAB support explicitly prohibiting the FCC from involuntarily reclaiming spectrum from broadcasters as well as from revoking their licenses or otherwise penalizing them for not taking part in the auctions? Yes or no.

Mr. SMITH. We support prohibiting that kind of action.

Mr. DINGELL. Now, Senator, furthermore, does NAB believe that FCC's incentive auction authority should be structured with clear limitations on its ability to repack and co-locate signals as well as an explicit mandate to protect broadcast contours? Yes or no.

Mr. SMITH. Yes.

Mr. DINGELL. Now, Senator, does NAB believe that broadcasters, both directly and indirectly affected by incentive auctions, should be fully compensated for their expenses relative to such auctions?

Mr. SMITH. Yes, sir.

Mr. DINGELL. Now, these questions to Chief Moore.

Mr., I have got to get a yes or no out of you, because I have 51 seconds.

Now, I have a simple question for you with respect to public safety. You have had many years of experience protecting and serving the public. Is relocating the D-block free of charge to the public safety the best way to ensure our country's first responders can do their jobs most effectively and save lives?

Mr. MOORE. Yes.

Mr. DINGELL. Thank you.

Mr. Chairman, I have 25 seconds to yield back.

Mr. WALDEN. Thank you. Nobody has mastered that better than you.

I have a number of things to enter into the record. Before I do that, though, we will have questions from other committee members who were otherwise detained in other committees. We would really appreciate a very rapid turnaround, because we actually value your response as we go through this process. So, to the extent we make questions available—and I know Mr. Bass had some—we would like a quick turn.

We thank you for your testimony, by the way, and your answers to our questions.

I will enter into the record unanimous consent statements from the High Tech Spectrum Coalition, which represents the major high-tech companies; the National Association of Broadcasters; CTIA–The Wireless Association; Verizon and AT&T statements lauding the majority's discussion draft. We always like to put those in the record. To enter into the record letters from Tech America, the National Association of Manufacturers, the Information Technology Industry Council and the Telecommunications Industry Association, as well as quotes from the FCC filings of Qualcomm, Motorola, and LG opposing a mandate on the manufacture of 700 megahertz wireless devices, and an FCC working paper from June

2010 that finds 10 megahertz provides more than the regional required capacity for day-to-day communications for public safety.

Without objection.

[The information follows:]

HTSC
High Tech Spectrum Coalition

FOR IMMEDIATE RELEASE

Contact: Jared Weaver

(202)548-2308

jweaver@alpinegroup.com

www.hightechspectrumcoalition.org

HTSC Praise Spectrum Discussion Draft

WASHINGTON, July 14, 2011 – "The members of the High Tech Spectrum Coalition (HTSC) are extremely pleased that the discussion draft recognizes the critical state of the country's spectrum resources and offers a concrete strategy that will spur innovation, create jobs, and ensure that consumers' wireless experiences meet their growing expectations," said Rhod Shaw, Executive Director of the HTSC. "The discussion draft makes the appropriate decision to meet this growing demand by relying upon voluntary incentive auctions and which will encourage the most efficient use of this scarce resource. The HTSC looks forward to continuing to work with the Committee as the bill moves through the legislative process and eagerly anticipates its enactment this year as the need for additional spectrum continues to grow."

HTSC includes Alcatel-Lucent, Apple, Cisco, Ericsson, Intel, Nokia, Qualcomm, RIM, and major high tech associations such as the Information Technology Industry Council (ITI), the Telecommunications Industry Association (TIA), and the Semiconductor Industry Association (SIA). HTSC urges Congress to promptly enact legislation authorizing the FCC to conduct voluntary incentive auctions.

Home (/default.asp)Newsroom (/news/default.asp)Statement of NAB President and CEO Gordon Smith on Discussion Draft House Spectrum Legislation (/documents/newsRoom/pressRelease.asp?id=2569)

FOR IMMEDIATE RELEASE
July 13, 2011

CONTACT
Dennis Wharton
202-429-5350
follow me

(http://www.twitter.com/AirWharton)

Statement of NAB President and CEO Gordon Smith on Discussion Draft House Spectrum Legislation

"NAB is grateful for the leadership of Chairmen Upton and Walden, who have demonstrated time and again a recognition of the unique and positive role played by free and local television stations in communities across America. Under their proposed draft legislation to provide truly voluntary spectrum auctions, the clear intent of Congress would be to protect tens of millions of viewers relying exclusively on broadcast television against loss of service. NAB will work in a bipartisan basis with them and other lawmakers as Congress continues to debate incentive auction proposals."

About NAB
The National Association of Broadcasters is the premier advocacy association for America's broadcasters. NAB advances radio and television interests in legislative, regulatory and public affairs. Through advocacy, education and innovation, NAB enables broadcasters to best serve their communities, strengthen their businesses and seize new opportunities in the digital age. Learn more at www.nab.org (http://www.nab.org).

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The Wireless Association®
CTIA is the International Association for the Wireless Telecommunications Industry, Dedicated to Expanding the Wireless Frontier

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CTIA-The Wireless Association® Statement on the Draft House Republican Spectrum Bill

July 14, 2011

WASHINGTON, D.C. – *CTIA-The Wireless Association ® Vice President of Government Affairs Jot Carpenter released this statement:*

"CTIA and the wireless industry believe the draft House Republican bill is an important and positive first step to address America's looming spectrum crisis while ensuring we remain the world's leading wireless industry. The facts prove our customers love accessing the mobile Internet anywhere and anytime. That's why our members want to purchase the unused and underutilized spectrum from the U.S. government for billions of dollars and then invest to continue the innovation throughout the wireless ecosystem while creating jobs for millions of Americans. The draft bill provides a pragmatic roadmap to accomplishing this goal. We look forward to working with Chairman Upton and Walden to keep this bill moving forward."

###

CTIA-The Wireless Association® (www.ctia.org) is an international organization representing the wireless communications industry. Membership in the association includes wireless carriers and their suppliers, as well as providers and manufacturers of wireless data services and products. CTIA advocates on behalf of its members at all levels of government. The association also coordinates the industry's voluntary best practices and initiatives, and sponsors the industry's leading wireless tradeshows. CTIA was founded in 1984 and is based in Washington, DC.

NEWS RELEASE

verizon

FOR IMMEDIATE RELEASE
July 13, 2011

Media contact:
Ed McFadden
202-515-2441
edward.s.mcfadden@verizon.com

HOUSE SPECTRUM BILL MOVING FORWARD

WASHINGTON – *Today (July 13), draft legislation for wireless spectrum and an interoperable public safety broadband network was released by the House Energy and Commerce Committee. The following statement should be attributed to Peter Davidson, senior vice president, federal government relations:*

"We are pleased to see the House Energy and Commerce Committee moving forward on spectrum legislation. This draft meets three goals Verizon has long supported: bringing much-needed new spectrum to the mobile market, an open auction for this spectrum, and progress toward a long-sought interoperable, national public safety broadband network. Achieving these goals will spur investment and innovation in the wireless marketplace and grow the U.S. economy, generate much-needed revenue to help reduce our national debt, and give first responders the 21st century communications tools they need to keep our nation safe.

"We look forward to working with Chairmen Upton and Walden, Ranking Members Waxman and Eshoo, and other Committee members as the legislative process continues."

####

VERIZON'S ONLINE NEWS CENTER: Verizon news releases, executive speeches and biographies, media contacts, high-quality video and images, and other information are available at Verizon's News Center on the World Wide Web at *www.verizon.com/news*. To receive news releases by e-mail, visit the News Center and register for customized automatic delivery of Verizon news releases.

at&t

July 14, 2011

AT&T STATEMENT ON UPTON/WALDEN SPECTRUM BILL

The following may be attributed to Tim McKone, AT&T Executive Vice President — Federal Relations:

"With the U.S. leading the world in mobile broadband usage and innovation, it is critical that additional spectrum is made available in the marketplace. We commend Chairmen Upton and Walden for putting forth legislation that offers constructive steps on addressing the spectrum crisis.

"We are very encouraged by the heightened attention being paid to this critical infrastructure problem that our country now faces, and look forward to working with the members of Congress on this important legislation."

###

Contact:
Claudia Jones
202.457.3933

TechAmerica
WHERE THE FUTURE BEGINS

TechAmerica.org

TechAmerica
601 Pennsylvania Avenue, NW
Suite 600, North Building
Washington, DC 20004
P 202.682.9110

June 30, 2011

The Honorable John D. Rockefeller
Chairman
U.S. Senate Committee on Commerce,
Science, and Transportation
254 Russell Senate Office Building
Washington, D.C. 20510

The Honorable Kay Bailey Hutchison
Ranking Member
U.S. Senate Committee on Commerce,
Science, and Transportation
560 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Chairman Rockefeller and Ranking Member Hutchison:

On behalf of TechAmerica, the U.S. technology industry's largest advocacy organization representing over 1,000 leading innovative companies, I'm writing to express our concern with an amendment, proposed but withdrawn by Senator Wicker, to S. 911, the Public Safety Spectrum and Wireless Innovation Act, on June 8 during the Commerce Committee's mark-up of the legislation.

Our organization represents the entire cross-section of mobile broadband industry participants, including wireless providers, device manufacturers, and chip makers, many of which have expressed strong reservations with Senator Wicker's proposed amendment which if successfully adopted would have required device interoperability across all paired commercial 700 MHz spectrum blocks. While Senator Wicker's amendment may have been drafted with good intentions, TechAmerica opposes such a requirement for a variety of reasons.

First, this mandate would unnecessarily contravene the Federal Communications Commission's ("Commission") 700 MHz band-specific rules that promote technological innovation by encouraging different licensees to use the blocks for different purposes. Having been in place for years now, those band-specific rules have been relied upon by licensees, device manufacturers, and chip makers as they work hard to deploy 4G mobile broadband throughout the United States. A congressional mandate requiring interoperability across all paired blocks in the 700 MHz band would run the risk of undermining and unnecessarily disrupting the progress being made to deploy 4G services, delay production of 4G devices, and therefore stifle a key component of the Commission's National Broadband Plan and Congress's mandate to "encourage the deployment on a reasonable and timely basis of advanced telecommunications capability."[1]

Second, for technical reasons, any requirement of device interoperability across the paired commercial 700 MHz spectrum blocks is impracticable, would introduce delay in placing products on the market, and would also increase the cost of devices. The 700 MHz spectrum in question is divided into a lower and upper band precisely because of the unique situation in the 700 MHz band implying certain interference concerns. These two defined bands within the 700 MHz band are not contiguous because the frequencies used for mobile transmission are not all contiguous and therefore could be seen as two totally independent bands. While it may be technologically feasible to overcome the complexities associated with non-contiguous banding, doing so would require a variety of implementation changes, including multiple duplexers, antennas, RF chipsets, and filters, that would drastically alter the form factor, functionality, and cost of a mobile device operating in those bands. Indeed, the additional and wider filters that would have to be used to ensure a device could operate across the entirety of the paired commercial lower and upper 700 MHz bands are less likely to mitigate interference, thus further stifling innovation and diminishing the quality of service in these bands.

---

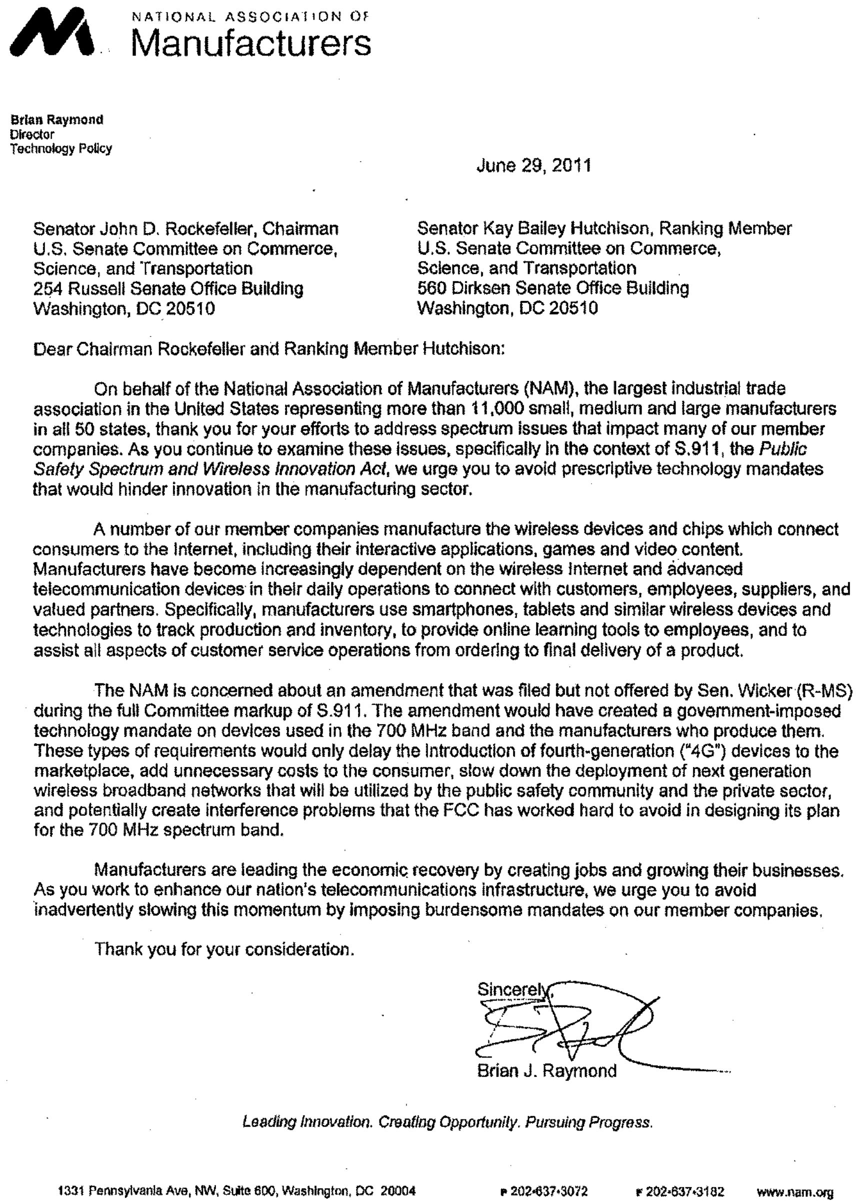
[1] Section 706(a) of the Telecommunications Act of 1996, 47 U.S.C. § 1302(a).

TechAmerica appreciates your efforts to address the insatiable demand for commercial spectrum through S. 911, a bill that both establishes voluntary incentive auctions for licensed spectrum and recognizes the tremendous value of unlicensed spectrum. We share the Committee's view that the voluntary repurposing of commercial broadcast spectrum for mobile broadband use will lead to tremendous technological innovation and job growth. As you continue to advance S. 911 through the legislative process, TechAmerica respectfully requests, for the reasons espoused above, that you refrain from accepting any proposal that would impose an unneeded technological mandate affecting the deployment and utilization of the 700 MHz spectrum.

Thank you for your time and attention to this vitally important matter.

Sincerely,

Phillip J. Bond
President and CEO



NATIONAL ASSOCIATION OF
Manufacturers

Brian Raymond
Director
Technology Policy

June 29, 2011

Senator John D. Rockefeller, Chairman
U.S. Senate Committee on Commerce,
Science, and Transportation
254 Russell Senate Office Building
Washington, DC 20510

Senator Kay Bailey Hutchison, Ranking Member
U.S. Senate Committee on Commerce,
Science, and Transportation
560 Dirksen Senate Office Building
Washington, DC 20510

Dear Chairman Rockefeller and Ranking Member Hutchison:

On behalf of the National Association of Manufacturers (NAM), the largest industrial trade association in the United States representing more than 11,000 small, medium and large manufacturers in all 50 states, thank you for your efforts to address spectrum issues that impact many of our member companies. As you continue to examine these issues, specifically in the context of S.911, the *Public Safety Spectrum and Wireless Innovation Act*, we urge you to avoid prescriptive technology mandates that would hinder innovation in the manufacturing sector.

A number of our member companies manufacture the wireless devices and chips which connect consumers to the Internet, including their interactive applications, games and video content. Manufacturers have become increasingly dependent on the wireless Internet and advanced telecommunication devices in their daily operations to connect with customers, employees, suppliers, and valued partners. Specifically, manufacturers use smartphones, tablets and similar wireless devices and technologies to track production and inventory, to provide online learning tools to employees, and to assist all aspects of customer service operations from ordering to final delivery of a product.

The NAM is concerned about an amendment that was filed but not offered by Sen. Wicker (R-MS) during the full Committee markup of S.911. The amendment would have created a government-imposed technology mandate on devices used in the 700 MHz band and the manufacturers who produce them. These types of requirements would only delay the introduction of fourth-generation ("4G") devices to the marketplace, add unnecessary costs to the consumer, slow down the deployment of next generation wireless broadband networks that will be utilized by the public safety community and the private sector, and potentially create interference problems that the FCC has worked hard to avoid in designing its plan for the 700 MHz spectrum band.

Manufacturers are leading the economic recovery by creating jobs and growing their businesses. As you work to enhance our nation's telecommunications infrastructure, we urge you to avoid inadvertently slowing this momentum by imposing burdensome mandates on our member companies.

Thank you for your consideration.

Sincerely,

Brian J. Raymond

Leading Innovation. Creating Opportunity. Pursuing Progress.

1331 Pennsylvania Ave, NW, Suite 600, Washington, DC 20004 P 202·637·3072 F 202·637·3182 www.nam.org

Information Technology Industry Council
Leading Policy for the Innovation Economy

June 22, 2011

Senator John D. Rockefeller
Chairman
U.S. Senate Committee on Commerce,
Science, and Transportation
254 Russell Senate Office Building
Washington, DC 20510

Senator Kay Bailey Hutchison
Ranking Member
U.S. Senate Committee on Commerce,
Science, and Transportation
560 Dirksen Senate Office Building
Washington, DC 20510

Dear Chairman Rockefeller and Ranking Member Hutchison:

On behalf of the Information Technology Industry Council (ITI), we would like to thank you for your persistent efforts to move S. 911, the Public Safety Spectrum and Wireless Innovation Act, through the Senate Commerce Committee on a bipartisan basis. ITI applauds your leadership in addressing the communications needs of public safety, as well as the pressing commercial demand for spectrum through a bill that both establishes voluntary incentive auctions for licensed spectrum and recognizes the value of unlicensed spectrum. We look forward to working with you as the bill continues moving through the Congressional process.

ITI has serious concerns about a proposed amendment by Mr. Wicker that was filed prior to the markup, but not offered for a vote. The amendment would have required device interoperability across the paired commercial 700 MHz spectrum blocks, which are divided into four bands. Such a requirement would not only limit industry's ability to bring innovative new products to market, it would negatively impact the consumer experience and device performance.

The most advanced handset chipsets available can only support two bands under 1 GHz, which allow for operation on one 700 MHz band and cellular. Requiring interoperability across the four 700 MHz bands plus cellular would result in handset makers having to install multiple chipsets, as no chips now or in the foreseeable future could meet such a mandate. Consumers want, and have come to expect that, devices will decrease in size while features and functions increase, and battery life improves. An interoperability requirement would turn those expectations on their head, resulting in more costly and bulkier handsets, fewer features and functions, and less battery life.

More importantly, an interoperability requirement will slow deployment of next-generation LTE networks that are being deployed based on independent standards that were developed over three years ago. Manufacturers and carriers would be required to redesign and restart deployment of LTE devices and equipment to comply with such a mandate. This would both delay the benefits of a next generation broadband network to

Chair: Pamela Passman, Microsoft • Vice Chair: Peter Cleveland, Intel •
Officers: Dean C. Garfield, President and CEO • Ralph Hellmann, Senior Vice President • John Neuffer, Vice President for Global Policy
• Rick Goss, Vice President for Environment and Sustainability

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consumers, but also public safety which will leverage advances from the 700 MHz commercial ecosystem.

The Public Safety Spectrum and Wireless Innovation Act will move our nation's spectrum policy forward significantly by transitioning the essential resource necessary to continue the unparalleled innovation we have seen in mobile devices, services, and applications to its highest valued use. We would urge you to consider the negative impacts technology mandates such as commercial interoperability requirements would have on innovation, device features and functions, and overall consumer experience.

Again, we thank you for your exhaustive work on S. 911, and look forward to working with you to solve public safety's communications needs, and move our nation's spectrum policy forward.

Sincerely,

Dean Garfield
President and CEO

TIA®

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June 23, 2011

The Honorable Roger Wicker
U.S. Senate Committee on Commerce,
Transportation & Science
555 Dirksen Senate Office Building
Washington, DC 20510

The Honorable Mark Begich
U.S. Senate Committee on Commerce,
Transportation & Science
111 Russell Senate Office Building
Washington, DC 20510

Dear Senator Wicker and Senator Begich;

On behalf of the Telecommunications Industry Association (TIA), I am writing to bring to your attention our industry's efforts and position regarding interoperability of commercial devices in the 700 MHz band. We understand that you are interested in requiring that all 700 MHz devices be capable of operating across all spectrum blocks in the 700 MHz band. However, our association would like to explain why a device mandate would cause harm to our member companies, consumers and could impede 4G broadband deployments.

TIA is a leading trade association for the information and communications technology industry, with over 500 member companies that manufacture or supply the products and services used in global communications. TIA's members are the manufacturers and suppliers of wireless devices and their component parts.

TIA has long held the position that a requirement that every 700 MHz device operate on all paired commercial 700 MHz frequency blocks ignores technological complexities and marketplace realities, and will stall progress to make 700 MHz devices rapidly available at reasonable cost. Product differentiation – not government mandates – has driven and will continue to drive competition in the wireless consumer industry. For example, the acceleration of Lower 700 MHz A-block deployments and the availability of devices as a result of technical advancements can resolve spectrum block challenges without a device mandate. Indeed, one manufacturer has already entered into an agreement with a carrier to provide Lower A block devices and another has announced that it will produce interoperable devices later this year. These developments make clear that no government intervention is warranted. Restricting manufacturers and carriers from being able to choose the air interfaces and product features that will best meet their customers' needs would deny consumers the full benefits of innovative wireless technologies and undermine the U.S. government's technology neutral policies.

Furthermore, the industry faces technical hurdles that impede the creation of devices that can operate across all 700 MHz bands. These include the need to insert additional components, such as filters, power amplifiers and switches, into devices to accommodate additional bands. Moreover, because of design constraints that affect size, cost, and other factors, adding components to enable operation across all 700 MHz bands is likely to require removing components that support other bands, which may limit the user's ability to roam onto other bands for national or international service. The number of bands that can be supported by a wireless device are limited and a handset likely cannot support both roaming and the operation across all 700 MHz bands. Any such requirement would necessitate the development of new designs which, combined with the technical attributes of such devices, will further escalate the cost of 700 MHz consumer devices and delay time-to-market. Finally, and critically, there is a real possibility that interference will result from requiring handsets to operate in all 700 MHz bands, as there is almost no guard band between any of the individual frequency blocks in the Lower and Upper 700 MHz bands.

Our equipment manufacturer member companies are committed to working with carriers and the FCC to overcome technical challenges with the overarching goal to resolve interference problems. We understand the desire to ensure interoperability within the 700 MHz band and we look forward to working with your offices to achieve this goal without imposing mandates that would undermine continued investment in wireless technologies.

Sincerely,

Grant Seiffert
President

CC: Chairman John D. Rockefeller and Ranking Member Kay Bailey Hutchison

Wireless Device Manufacturers on 700 MHz Device Mandates

Excerpts from FCC Docket RM-11592

Qualcomm

"...grant of the relief requested in the Petition would: (1) delay any mobile broadband deployments at 700 MHz for an unspecified period of time; (2) drive up the costs of devices supporting the Lower and Upper 700 MHz bands by an unspecified amount; (3) imperil Qualcomm's ongoing development of chipsets for the Lower and Upper 700 MHz bands; and, above all, (4) unnecessarily deprive American consumers of new mobile broadband networks and devices."

Comments of Qualcomm, Inc., *In re: Petition for Rulemaking Regarding 700 MHz Band Mobile Equipment Design and Procurement Practices*, RM-11592, at 1-2, *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=7020399924.

Motorola

"Motorola urges the Commission to dismiss the petition as the requested relief would unnecessarily delay the deployment of 700 MHz mobile broadband devices, including those designed to operate on public safety broadband spectrum"

Comments of Qualcomm, Inc., *In re: Petition for Rulemaking Regarding 700 MHz Band Mobile Equipment Design and Procurement Practices*, RM-11592, at 1, *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=7020399966.

LG Electronics

"The Petition should be denied because the requested regulatory intervention would, at minimum, delay mobile broadband deployment at 700 MHz and reduce the ultimate utility of 700Mhz capable devices with respect to interoperability and roaming. More seriously, it would also threaten the long term viability of the 700 MHz band for new broadband services by unnecessarily complicating the design of 700 MHz devices and rendering such devices commercially unattractive"

Letter from Alan K. Tse, Vice President, General Counsel, LG Electronics MobileComm USA, Inc. to Marlene Dortch, Secretary, Federal Communications Commission, *In re: Petition for Rulemaking Regarding 700 MHz Band Mobile Equipment Design and Procurement Practices*, RM-11592, *available at* http://fjallfoss.fcc.gov/ecfs/document/view?id=7020504629.

Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

FCC White Paper

The Public Safety Nationwide Interoperable Broadband Network: A New Model for Capacity, Performance and Cost

June 2010

The Public Safety Nationwide Interoperable Broadband Network: A New Model for Capacity, Performance and Cost

The Federal Communications Commission ("FCC") has performed a technical analysis of the capacity and performance of the public safety broadband network assuming that the National Broadband Plan recommendations concerning this network are implemented. This analysis includes examining different emergency situations based on actual experiences and as submitted in the record of the National Broadband Plan. This analysis shows:

1. The 10 megahertz of dedicated spectrum allocated to public safety in the 700 MHz band for broadband communications provides more than the required capacity for day to day communications and for each of the serious emergency scenarios set forth below.
2. For the worst emergencies for which public safety must prepare, even access to another 10 megahertz of spectrum would be insufficient. Accordingly, priority access and roaming on the 700 MHz commercial networks is critical to providing adequate capacity in these extreme situations. Moreover, priority roaming is a cost-effective way to improve the resilience of public safety communications, along with its capacity, in a way that a single network cannot provide.
3. The capacity and efficiency of a public safety broadband network will far exceed the expectations of someone who has only experienced narrowband land mobile radio (LMR). This is because of the system architecture, density of cell sites, the density of cell sectors per site, network and spectrum management, and the use of new and emerging technologies,
4. Public safety can make more capacity available when and where it is needed by using all of its spectrum resources appropriately and effectively, no matter how much spectrum is available (*e.g.*, use the 700 MHz band for mobile devices and other frequency bands for fixed devices).

Jon M. Peha, PhD[1]
Chief Technologist

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[1] The authors of this paper are Jon M. Peha, Walter Johnston, Pat Amodio and Tom Peters.

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I. Introduction

In March 2010, the FCC released the National Broadband Plan (NBP), which makes significant recommendations for improving access to broadband communications across America. A critical issue the NBP addressed was how to ensure the availability of broadband communications for public safety and emergency response on a cost-effective and technically feasible basis. For many years this issue has gone unresolved; today the goals of mission critical broadband networks for public safety use and nationwide interoperability for public safety communications have not yet been achieved.

The NBP proposes a cost-effective and technically viable strategy for the creation and deployment of a nationwide interoperable public safety broadband wireless network for first responders and other public safety personnel. The recommendations in the NBP comprise a comprehensive plan to provide the public safety community with the capacity, performance, nationwide coverage, interoperability, technological growth and affordability required for reliable, nationwide, interoperable broadband communications.

The cornerstone of the NBP's public safety recommendations is the utilization of 10 megahertz of dedicated 700 MHz spectrum, currently designated by Congress for public safety use. In order to exploit this asset, the NBP recommends that this spectrum be utilized by public safety agencies through the creation of incentive-based partnerships with commercial entities, such as 700 MHz broadband service providers, to construct the public safety broadband network in a cost-efficient manner by leveraging commercial technologies and infrastructure, with the support of public funding. The NBP also recognizes the importance of commercial use of the D block because it shares the same LTE band class as the public safety broadband spectrum. As the D block is developed and deployed for commercial use, public safety will be able to leverage the commercial economies of scale associated with that band in its own frequency allocation, something the other 700 MHz bands do not offer as affordably.

While 10 megahertz of dedicated spectrum will support the core of the public safety broadband network, the NBP also recognizes that it is critical that the public safety community have access to additional capacity in the worst emergencies. Accordingly, the NBP recommends that the FCC adopt rules to ensure that public safety users are able to roam and obtain priority access on commercial broadband wireless networks— across the 700 MHz band commercial spectrum. The NBP also envisions that coverage and capacity of the public safety broadband network will be supplemented through in-building systems and through provision of deployable cell sites and vehicular relays.

This paper provides the FCC's analysis of why the NBP recommendations will provide public safety users across the country with required broadband wireless network capacity and performance, both on a day-to-day basis and during emergencies, while ensuring that the approach is cost-effective and technically feasible.[2]

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[2] In a separate paper, the Omnibus Broadband Initiative explained in detail the NBP's cost model for the nationwide public safety broadband network. *See* Omnibus Broadband Initiative, A Broadband Network

II. Why the Plan Meets Public Safety Capacity Requirements: Baseline Capacity

In accordance with the Budget Act of 1997, FCC rules allocate 24 megahertz of dedicated spectrum to public safety in the 700 MHz band, bringing public safety's total spectrum allocation to 97 megahertz. This 24 MHz allocation makes public safety among the largest holders of spectrum in the 700 MHz band. The FCC designated 10 megahertz of this 24 megahertz for broadband use.[3] Even if one only considers this 10 megahertz of spectrum allocated for broadband use, public safety would have 200 thousand users per megahertz.[4] This is considerably fewer users than the estimated number of users that commercial broadband providers will support in an equivalent amount of similar spectrum. Accordingly, 10 megahertz of spectrum is a relatively large allocation for public safety's routine communications traffic. Furthermore, our analysis demonstrates that 10 megahertz of spectrum will provide significant capacity for the public safety broadband network on a day to day and emergency basis.

> Public safety has a total of 97 MHz of spectrum allocated for use across the RF spectrum with 60 MHz of that total available for broadband use. Overall, the allocation of spectrum per user for public safety is now 25 times that of commercial providers.

Providing an additional 10 megahertz of spectrum to public safety would not guarantee public safety sufficient capacity for the worst emergencies. Priority access and roaming onto commercial bands can provide public safety with far more capacity during periods of greatest need. Further, reallocation of the D block would result in several severe detriments, including:

- The cost of the network and the associated mobile devices could increase significantly. The benefits associated with sharing an LTE band class (Band Class 14) with the commercial D block licensee would evaporate. Equipment vendors would not be able to rely on the broader commercial LTE market in Band Class 14. Accordingly, equipment costs could be much higher then estimated.

Cost Model: A Basis for Public Funding Essential to Bringing Nationwide Interoperable Communications to First Responders (rel. Apr. 2010) (*Cost Model Paper*), *available at* http://www.fcc.gov/pshs/docs/ps-bb-cost-model.pdf (last visited May 10, 2010).

[3] In the 1997 Budget Act, Congress specifically determined that public safety would be provided with 24 megahertz of spectrum from the 108 megahertz of spectrum recovered from the DTV transition and the remainder of the spectrum was to be auctioned. Of this 24 megahertz, 12 megahertz has been designated for dedicated voice systems using traditional trunked technology and 2 megahertz is used as an internal guard band.

[4] 170 megahertz: This includes the cellular and PCS bands; 547 megahertz: This includes the 700 MHz (formerly TV), AWS1, and EBS/BRS bands, a substantial portion of which is not currently in use; Public Safety: According to the Bureau of Labor Statistics, U.S. Department of Labor, there are 1.1 million police, fire and EMS professionals. This number excludes some first responders, such as volunteer firefighters. For this analysis, we assume 2 million public safety users. 97 megahertz: This includes the 700 MHz (formerly TV) and 4.9 GHz bands, a substantial portion of which is not currently in use.

- Technological evolution might be slowed. Without a Band Class 14 commercial partner, vendors may have less incentive to advance the technology envelope in this band class without significant cost imposed on public safety.
- In most cases, this spectrum would be severely underutilized.

A. Network Capacity Drivers

Many people equate capacity with spectrum. While spectrum is one of the resources being utilized, the amount of spectrum available to a network alone is not a meaningful measure of network performance and capacity. Network capacity and performance are dramatically improved through many factors in addition to the amount of spectrum. These factors include the type of architecture employed, the number of cell sites in operation, the number of sectors per cell, sound network and spectrum management, and the specific technology that the network utilizes. Accordingly, in order to analyze the capacity and performance of any given network, a multitude of factors must be evaluated in relation to one another. Relying solely on the amount of spectrum available to a network is a flawed way to evaluate the capacity of a network, and doing so could lead to seriously flawed and expensive decisions.

A significant driver of cellular network capacity is available infrastructure to support the network. In a cellular architecture, as recommended in the NBP, spectrum can be reused most efficiently, yielding greater network capacity, when a network utilizes an increased number of cell sites for a given geographic area because this technique enables greater spectrum reuse with minimal interference. To first approximation, the total capacity that a cellular architecture can provide to a given region can be described by the following equation.

$$\text{Total capacity} = \frac{(\#\text{ of sites}) * (\#\text{ of sectors per site}) * (\text{Capacity/MHz}) * (\#\text{ of MHz of spectrum})}{\text{Frequency Reuse Factor}}$$

Accordingly, two networks with the same amount of spectrum covering the same geographic area can have widely disparate capacity just by changing the number of cell sites available for network use in the relevant service area. It is for this reason that sound network engineering principles have dictated that commercial networks generally are built out using a dense number of cell sites. This enables these networks to be operated in a spectrally efficient manner by leveraging additional infrastructure, as opposed to spectrum, and to utilize a cost-effective means to increase network capacity.

Cellular networks also increase capacity through the deployment of spectrally-efficient advanced technologies. As commercial wireless carriers migrate to 4G standards such as LTE, it is estimated that the networks using this technology will provide more capacity (Mb/s) per megahertz of spectrum in any given cell than earlier technologies. As in the past, commercial cellular networks experience significant improvements in capacity per megahertz as technology advances, and further improvements are expected with LTE. In addition, advances in compression technology, particularly for video, means that new technologies hold the promise that the same piece of information (*e.g.* a video stream) can be carried using less capacity. The commercial marketplace has benefited greatly from such developments as new technologies are introduced.

In contrast, if technology is developed exclusively for a much smaller market, such as public safety, the pace of improvements is likely to be slower. This is one of many reasons that the NBP recommends an approach for public safety broadband communications that leverages the advantage of technologies and standards that are gaining commercial use whenever they are suitable for public safety purposes, including the use of LTE technology for the radio access network. This is also why the NBP recommends the commercial auction of the D block, to ensure a potential partner in the same LTE Band Class as public safety. This approach provides public safety with access to commercial technologies that have generally been shown to advance more quickly to increase spectral and other operating, as well as cost, efficiencies.

Another way to increase capacity is to provide supplemental infrastructure to expand available capacity. There are unique strategies for increasing capacity within buildings, where a substantial amount of cellular network traffic originates. Additional infrastructure, such as distributed antenna systems (DAS) and pico cells, can be installed inside buildings to improve coverage and offload traffic from external cell towers. These approaches decrease strains on the available cell site infrastructure. The NBP recommends that building codes be changed or enacted to enable greater use of these technologies and that FCC rules be developed that enable and facilitate their use. Further, additional outreach by the federal, state and local governments to building and facility owners can assist in ensuring that this technology is widely pervasive as 4G networks are deployed.

Capacity can be further expanded by utilizing deployable communications systems, such as next generation cell sites on wheels (a.k.a. "COWs" or "COLTs"[5]) and vehicular relays, as is frequently done with today's wireless technologies during disasters and major incidents or events. The NBP recommends deployment of these technologies for public safety broadband use, through a program that would help fund caches of equipment throughout the country that can be rapidly deployed to the site of any major disaster.

Further, sound spectrum management must also be considered. For example, to meet day-to-day fixed needs for applications like video monitoring, the public safety community should rely on other transmission technologies, such as fixed wireline and fixed wireless technologies, which will enable public safety to preserve its 700 MHz capacity for mobile broadband communications. By ensuring that the overall public safety communications network leverages all existing resources most suited to the intended purpose, public safety can have access to the most robust and reliable communications network possible, on a cost-effective basis.

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[5] "COW" and "COLT" are common industry terms for Cell On Wheels and Cell On Light Truck.

In addition, as discussed, supra, utilizing the communications networks of other network operators is another way to increase network capacity and provide a capability backstop to public safety. There may be times that 10, 20 or even 30 megahertz of capacity, even with sound network design and management principles might be insufficient to support demands during a major incident. In these cases, it is critical that public safety have access to additional broadband wireless networks, such as those operated by commercial network operators. Guaranteeing access to these networks will enable the public safety community to have access to substantially more capacity than a dedicated network can provide without vastly more dedicated spectrum than is under consideration. Roaming with priority access will also provide increased reliability and resiliency, especially if any roaming partner utilizes different cell tower sites for all or some of its network.

In conclusion, the amount of spectrum is only one of several interrelated factors in determining capacity and is influenced by other factors, such as increasing the number of sites, maximizing the sectors per site and using advanced technologies to achieve greater capacity per megahertz. As long as sound network management is adhered to, including the provision of adequate funding to construct sufficient cell sites in the network area, the deployment of cutting-edge technology in each cell site, and the use of supplemental tools to increase capacity, network capacity for public safety communications will be significant in 10 megahertz of dedicated capacity. As this paper will show, our analysis demonstrates that by deploying sufficient infrastructure and using sound spectrum management principles, the 10 megahertz of dedicated public safety spectrum can meet public safety capacity and performance requirements in circumstances that range from routine day to day use to serious emergencies.

B. Public Safety Communications Today

Unless we are able to get past the mindset that network capacity is synonymous with spectrum, it would be natural to expect that the capacity from this 10 megahertz block at 700 MHz will be comparable to what public safety has experienced in the past. This is not the case. The public safety LMR networks in use today consume a large amount of spectrum per user.[6] This occurs in part because of legacy network design and technical considerations: public safety networks utilize radio systems with a relatively small number of high site towers and very sensitive radios. This technology and design greatly increases the amount of spectrum needed per user when compared to cellular architectures, which are used for today's commercial communications networks. Further, unlike cellular commercial systems, public safety communications have generally been locally operated which necessarily results in spectrally inefficient overlapping, independent networks. The NBP recommends that the public safety broadband network utilize a cellular architecture with LTE technology[7] and be deployed in a coherent manner throughout larger non-overlapping geographies. This should result in dramatic increases in spectrum and cost efficiencies, while handling heavier traffic demands than currently exist.

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[6] Not including spectrum allocations in the 4.9 GHz and 700 MHz bands, over 23 megahertz of spectrum have been allocated for public safety use. Public safety LMR networks use frequencies in the 25-50 MHz, 150-174 MHz, 220-222 MHz, 450-470 MHz and 806-824/851-869 MHz bands. In some metropolitan areas public safety also uses frequencies in the UHF T-Band (470-512 MHz).

[7] The Public Safety and Homeland Security Bureau (Bureau) sought comment on the Public Safety Spectrum Trust's (PSST) filing and the National Public Safety Telecommunications Council's Broadband

Due to the spectrum efficiency of modern digital technologies and the movement towards larger network operation areas, analysis of the required capacity for the public safety broadband network must not rely on assumptions based on today's technology and LMR network designs. A coherent, nationwide public safety broadband network with a modern cellular architecture and the same 4G technology that is used commercially (LTE) will offer public safety users far more capacity on 10 megahertz of spectrum than would be the case if a traditional LMR-type network were deployed. For example, a recent study of public safety communications in the greater Los Angeles area showed that a shift from today's LMR technology to even a pre-LTE cellular technology could increase capacity per megahertz by a factor of 16. In other words, the study demonstrated that 10 megahertz of capacity on a cellular network would be the equivalent of 160 megahertz on an LMR-type network.[8]

It would be a mistake to design a network based upon the public safety's past experience in using spectrum. Public safety agencies do not have significant incentives to use spectrum efficiently, because, unlike commercial entities, public safety agencies in America do not pay for spectrum. Accordingly, using spectrum inefficiently is not a cost. However, constructing adequate infrastructure is a cost even when that cost would result in improved communications and reduced costs over the long term. Nevertheless, both spectrum and infrastructure are costly. Spectrum is a scarce public resource and receives a high price at auction for its exclusive use, because it is highly valued resource, especially in the bands below 3 GHz.[9] On the other hand, it can be expensive to acquire, engineer, build and operate additional cell sites (although establishing new cell sites on existing towers, as recommended in the NBP, can decrease these costs significantly). In general, cellular networks achieve sufficient capacity for their users by balancing the costs of acquiring spectrum with the costs of adding sites—not by minimizing one cost without serious consideration of the other.[10]

Task Force (NPSTC BBTF) recommendations. *See* Comment Sought on NPSTC Broadband Task Force and Public Safety Spectrum Trust Technical Recommendations for 700 MHz Public Safety Broadband Deployments, PS Docket. 06-229, *Public Notice,* DA 10-458 (rel. Mar. 17, 2010) (*NPSTC PN*). Commenters were generally supportive of the technical recommendations of the NPSTC BBTF, including the mandatory use of Long Term Evolution (LTE) as an air interface, while recognizing that this standard is not yet fully developed. *See, e.g.,* Motorola NPSTC PN Comments at 1-2; IP Wireless NPSTC PN Comments at 1; Harris Corp. NPSTC PN Comments at 3.

[8] J.M. Peha, "How America's Fragmented Approach to Public Safety Wastes Money and Spectrum," *Telecommunications Policy,* Vol. 31, No. 10-11, 2007, p. 605-618.

[9] At Auction 73 in 2008, for example, winning bids for the 700 MHz A, B, C and E blocks totaled approximately $19 billion. *See* Federal Communications Commission, Auction – Auction 73, http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=73.

[10] In recognition that cell sites have significant capital costs associated with them, the NBP recommends public funding, based on a cost-effective incentive-based partnership approach, to ensure there are an adequate number of sites available for the nationwide public safety broadband network, whether in rural or urban parts of the country.

The NBP recommendations for the public safety broadband network include the deployment of 44 thousand sites nationwide,[11] and a cost effective approach for funding this network in a manner that enables an efficient use of the 10 megahertz of dedicated public safety spectrum to meet important public safety requirements. This would give the public safety network at 700 MHz a site density comparable to commercial providers, and a total site count greater than all but two of these providers, even though the commercial providers typically serve user densities that are greater by an order of magnitude or more. In addition to providing significant aggregate capacity, this high site density is necessary because public safety requires a level of signal reliability (i.e., the ability to get a strong signal when needed) that is more stringent than users of commercial systems demand. Regardless of the amount of capacity needed or the amount of spectrum available, high signal reliability requires a high cell site density.

To compensate for limitations in public safety narrowband communications systems in terms of capacity, public safety has been allocated significant amounts of spectrum. Even if we examine only the spectrum allocated to public safety use and commercial use before 2002, we find that public safety has been allocated more than 20 times as much spectrum per user as commercial providers. In recent years, allocations to both public safety and commercial providers have been greatly increased, including spectrum at 700 MHz (although not all of this spectrum is currently being utilized). Public safety has a total of 97 MHz allocated for its use across the RF spectrum with 60 MHz of spectrum which can be used for broadband. Using 2010 data, the allocation of spectrum per user for public safety is now 25 times that of commercial providers.

Cellular architecture, advanced technology, and the accompanying funding to deploy it mean that a more spectrally- and cost-efficient approach can be taken, and this huge gap in spectral efficiency can be reduced. Instead, public safety, using current technologies, larger geographic service areas, sufficient infrastructure, and sound spectrum management principles, should be able to operate more efficiently and support increased traffic demands within less spectrum than previously experienced. Further, because of the use of commercial technologies, public safety communications no longer has to operate in a silo. Instead, public safety can access additional networks for spikes in capacity demands, such as during particularly large emergencies.

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[11] *See Cost Model Paper.*

III. How the Plan Meets Public Safety Capacity Needs; Capability Back-stop

As discussed above, capacity depends on factors such as architecture, technology, and the number of sites, as well as amount of spectrum. Under NBP recommendations, public safety would have architecture, technology, and a number of sites comparable to leading commercial providers. Moreover, by commercial standards, 10 megahertz would be a large allocation to serve this number of users. For example, even if we completely disregard the 87 megahertz of spectrum public safety has outside this band, and we include spectrum recently allocated to commercial providers that is not yet in use, commercial providers would serve 2.7 times as many users per megahertz as public safety. (If we exclude commercial allocations made since 2006, because infrastructure has not yet been fully deployed in many of these bands, commercial providers would serve 8.5 times as many users per megahertz.) Commercial providers would need their current allocation and 900 megahertz of new spectrum before the amounts of spectrum per user were the same. Thus, if the routine needs of public safety users are comparable to, or twice as great as, those of commercial users, this combination of infrastructure build-out and spectrum would meet those needs.[12]

Nevertheless, for public safety communications, we must look beyond routine communications use to ensure that there is sufficient capacity available when major emergencies occur. As shown in the Appendix, our analysis demonstrates that 10 megahertz of dedicated spectrum will likely provide a significant amount of capacity and the required performance when used with 4G technology and sufficient infrastructure. The Appendix presents a series of specific scenarios: a "dirty bomb" attack at Manhattan's Penn Station,[13] a projected 12 year growth model for routine use of broadband services in New York City, a bridge collapse in Minneapolis, and a hurricane in Houston. This analysis determines that a system deployed in 10 megahertz of spectrum with the number of sites proposed in the FCC Cost Model[14] would have sufficient capacity for estimated broadband communications in each of these scenarios.

As these scenarios demonstrate, and as supported by the record and past public safety broadband experience, the most demanding application with respect to capacity is likely to be high-data-rate applications such as mobile video. In order to support the potential for video demands during times of emergency, it is important to look first at sound spectrum management policies that ensure that capacity is properly allocated among users and available networks and technologies. Second, for the rare times when additional capacity is actually needed, such as when the public safety network is not available, the NBP recommends that public safety have roaming and priority access on commercial wireless broadband networks. This will provide a safeguard to ensure that public safety has access to multiple, redundant networks with significant additional capacity when it is needed. Further, the public safety community can enter into additional spectrum sharing arrangements with other commercial partners. In these scenarios, it is likely that in extreme emergencies with heavy video or other high-bandwidth requirements, far more capacity will be required.

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[12] This is consistent with the 2008 FNPRM which concluded that all communications for public safety could be supported within these 10 megahertz except under unusual circumstances. Under the rules proposed, public safety could supplement its 10 megahertz by accessing a limited portion of the D block if and only if the President or a state governor declares a state of emergency, the President or a state governor issues an evacuation order impacting areas of significant scope, the national or airline sector threat level is set to red, the National Weather Service issues a hurricane or flood warning likely to impact a significant area, other major natural disasters occur, such as tornado strikes, tsunamis, earthquakes, or pandemics, manmade disasters or acts of terrorism of a substantial nature occur, power outages of significant duration and scope occur, or the national threat level is set to orange.

[13] *See* City of New York Ex Parte Filing, PS Docket No. 06-229, 700 MHz Public Safety Broadband Applications and Requirements at 34-40 (Feb. 23, 2010) (*New York City Paper*).

[14] *See Cost Model Paper.*

A. Ensuring Capacity During Huge Demands or When the Network is Unavailable

Public safety communications capacity demands are generally modest (though support critical communications requirements), with occasional spikes during emergencies.[15] Public safety must have adequate capacity to accommodate large capacity requirement spikes if and when they do occur. However, allocating dedicated resources to public safety to support the largest spike imaginable would leave a great deal of capacity unused between spikes. It is impossible to anticipate the timing of spikes. Reserving dedicated spectrum for these extreme emergencies would be grossly inefficient and waste two scarce resources: money and spectrum.

Further, even with 20 megahertz of spectrum, it is extremely unlikely that in the most video-dependent or most high-bandwidth response situations that public safety would have adequate capacity. The most cost-effective and spectrally efficient way to meet the emergency communications needs of the public safety community is through providing adequate infrastructure and spectrum sharing – ensuring a backstop capability for times when the public safety network is unavailable or there is a huge surge in demand. This can be best achieved through the implementation of the NBP's recommended priority access and roaming regime.[16] The FCC has plans to begin a rulemaking that will result in the implementation of this priority access and roaming regime in the near term.

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[15] For example, as was observed based on usage data from Denver's public safety communications systems, "[m]odern public safety wireless communications systems are generally designed for the worst-case scenario: a large-scale event which requires communication between large numbers of first responders, potentially from diverse agencies. . . . Most of the time, these systems operate at the low end of their designed-for capacity." Joshua Marsh, "Secondary Markets in Non-Federal Public Safety Spectrum," *Telecommunications Policy Research Conference* (2004). In addition, at its peak, the Minneapolis system handled over two times the number of calls during the I-35W bridge collapse that it would typically expect. During the busy-hour of September 17, 2008, the Harris County Regional Radio System handled almost twice as many PTTs than it would handle on a typical day. *See* Federal Communications Commission, Emergency Communications during the Minneapolis Bridge Disaster: A Technical Case Study of the Federal Communications Commission's Public Safety and Homeland Security Bureau's Communications Systems Analysis Division at 16-17 (2008) (*Minneapolis Bridge Case Study*), *available at* http://www.fcc.gov/pshs/docs/clearinghouse/references/minneapolis-bridge-report.pdf; *see also* Federal Communications Commission, Emergency Communications During Hurricane Ike: Harris County Regional Radio System: A Technical Case Study by the Federal Communications Commission's Public Safety and Homeland Security Bureau's Communications Systems Analysis Division at 12-13 (2009) (*Hurricane Ike Case Study*), *available at* http://www.fcc.gov/pshs/docs/clearinghouse/case-studies/Hurricane-Ike-Harris%20County-120109.pdf.

LTE technology is particularly promising with regard to priority access and roaming. As part of its current standard it allows network operators to assign different priority levels to different users or services, such that low-priority users have restricted use of network resources. Moreover, with IP (Internet Protocol) and LTE technology, it is possible to prioritize traffic in a way by which capacity is transferred to the highest and best use. Such prioritization schemes have been used successfully in military systems. The LTE standard is bringing these capabilities to wireless cellular systems.

B. Possible Future Capacity Expansions

In analyzing network capacity, it is also important to ensure that there is room for expansion and growth. Generally, a simple way to increase capacity is to increase the number of cell sites in a network. This can be done at a relatively low cost by exploiting commercial and other existing infrastructure wherever it is appropriate.[17] Accordingly, by using a constant amount of spectrum and expanding infrastructure deployment, network capacity can be increased.

Furthermore, LTE is at an early stage of technology development, and it will continue to progress. The NBP recommendation to leverage this commercial technology provides an opportunity for public safety communications to benefit from commercial technology advances, including increases in spectrum efficiency. Commercial operators are constantly upgrading their network capabilities to take advantage of greater spectrum and operational efficiencies. The NBP's incentive-based partnership applies this approach to the public safety broadband network.

C. Efficient Use of Public Safety Spectrum

Finally, public safety users can ensure adequate capacity through good stewardship of the broadband spectrum that is allocated to them. The 700 MHz public safety broadband spectrum has excellent propagation characteristics for mobile wireless broadband services and the public safety community should manage it as efficiently as possible. This includes ensuring that the public safety broadband spectrum is used for its best use: mobile use. Public safety should look to utilize fixed wireline and fixed wireless systems for some applications that are better supported by these technologies. A good example of this is video surveillance. For example, in addition to its allocations under 1 GHz, public safety has exclusive use of 50 megahertz of the 4.9 GHz band on a flexible basis which is well-suited for fixed uses, such as video surveillance.

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[16] This commercial spectrum would be used for commercial purposes when not required for public safety use.

[17] *See Cost Model Paper.*

Governance procedures are also an important component of sound spectrum management practices. For example, public safety needs to prioritize particular applications among incident commanders. This is an area on which the Emergency Response Interoperability Center (ERIC) and its federal partners can work with the public safety community. It is particularly important that public safety has access to capacity across its network; whether its dedicated 10 megahertz of public safety broadband capacity or the capacity of its roaming partners, in a manner that best supports the pubic safety community's needs at any one time.

D. The Role of Video and Future Bandwidth Intensive Applications

As previously discussed, mobile video is an example of one bandwidth-intensive application where capacity constraints may be experienced no matter the total amount (*e.g.*, 10, 20 or even 25 megahertz) of dedicated spectrum available to pubic safety for broadband communications. First, no matter how much capacity public safety has available to it, public safety network engineers must consider the appropriate data rate for mobile video. Not only must there be sufficient aggregate capacity to support all of the video devices in operation, but the system must be designed such that a single video device can operate even when it is at the edge of a cell. The data rate and performance available to a device in a cellular broadband network is a function of how far it is from a transmission tower. This is particularly important for video uplinks. The received power levels from an end-user device, not the amount of spectrum, are the limiting factor that determines the maximum video uplink data rate. A network that must be capable of supporting a video device or other device that supports a high-data-rate application must therefore have smaller cell radii, even if very few such devices will be used. Since smaller cells means more cells for a given area, requiring a network to support higher-data-rate video increases costs.

Leading organizations representing public safety, represented by the National Public Safety Telecommunications Council (NPSTC), have stated that a system that supports 256 kb/s per video device throughout the coverage area, including edge of cell, is sufficient for public safety in urban areas (and lower data rates are acceptable in suburban and rural areas).[18] This does not limit fixed devices located near a transmit tower, but typical mobile hand-held video devices must be capable of operating at 256 kb/s or less. The Department of Homeland Security's SAFECOM Program has stated that the preferred data rate for video depends on its use and purpose. 256 kb/s is acceptable for tactical and live surveillance of large targets, but for small targets, 512 kb/s may be needed.[19] Under these recommendations, average video rates would fall somewhere between 256 and 512 kb/s. A great deal of tactical capability – currently unavailable to public safety users – can be made available through a mobile network that supports these data rates.

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[18] *See* National Public Safety Telecommunications Council, Public Safety 700 MHz Broadband Statement of Requirements at 39 (2007).

[19] *See* Department of Homeland Security, SAFECOM Program, Public Safety Statement of Requirements for Communications & Interoperability Volume I (2006) and Volume II (2008).

However, a few vendors of high-data-rate video equipment have argued that the public safety broadband network must support 1.2 Mb/s or even 3.5 Mb/s for each video device, which is enough to carry standard-definition television (SDTV) and high-definition television (HDTV), respectively. While, of course, any public policy must strive to maximize public safety's tactical capabilities, the policy must also be grounded in practical assumptions. Because of the uplink power limitations of video devices, high speed uplink from the cell edge can only be supported at a limited distance from the cell site. Hence, video uplink speeds of greater than 1 Mbps from the cell edge, as suggested by a few vendors, will require vastly more cell sites than would otherwise be necessary. This cell limitation is independent of the amount of spectrum. Consider the cost of a coverage-limited network that can support a single 1.2 Mb/s device at the edge of a cell and that is otherwise built to the same standards as recommended in the NBP.[20] A coverage-limited network requires fewer cell sites than capacity-limited networks, and therefore costs less, so we can use this coverage-limited network to get a reasonable lower bound on the cost of a network that can support 1.2 Mb/s. We estimate that a coverage-limited network supporting 1.2 Mb/s would require 2.85 times as many cell sites, and both capital expenditures (CAPEX) to construct the network and operating expenditures (OPEX) to operate, maintain and upgrade the network are roughly proportional to the number of cell sites. Thus, by increasing the required data-rate-per-device to 1.2 Mb/s, a nationwide network that would have cost only $14 billion would instead cost $40 billion.

Of course, increasing the number of cell sites nationwide by a factor of 2.85 to support a single 1.2 Mb/s stream at edge of cell would have the effect of dramatically increasing aggregate capacity. This unavoidable expansion in aggregate capacity means a much larger number of video streams can be supported, without increasing the spectrum allocation beyond 10 megahertz. Indeed, a system operating in 10 megahertz of spectrum and designed to support 1.2 Mb/s video devices by deploying 2.85 times more sites than was proposed in the NBP would have more aggregate capacity than a system operating in 20 megahertz that has the amount of infrastructure proposed in the NBP.[21]

As noted above, we are not denying the value of mobile video capability to public safety. Indeed, we recognize that use of mobile video is likely to be a key tactical capability provided by the public safety broadband network. However, we emphasize that a significant degree of capability can be provided at bitrates that are much more reasonable from a cost-benefit standpoint over a mobile 700 megahertz system. To the extent that public safety agencies require high-definition, full frame video capabilities, some of these services are more cost effectively accommodated using other spectrum.[22]

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[20] *See Cost Model Paper.*

[21] There is one way to overcome the problems highlighted above and provide much higher data rates for video anywhere in a cell: one can use higher-gain antennas than is typical for commercial handsets, and perhaps higher-power transmitters. Users of commercial cell phones typically prefer smaller form factors rather than superior antennas, but this is presumably not an issue for a public safety command center. In effect, a device with a high-gain antenna at the edge of the cell can communicate as if it were much closer to the center of the cell. While this technology makes it possible to transmit at higher rate, it also reduces the effective consumption of network capacity, so high-data-rate video provided in this way does not create a problem for the network operating at 700 MHz.

E. The Effect of Interference

Adjacent cell interference can also impact the capacity of a wireless network. In the past, there have been instances in which public safety's LMR networks experienced levels of interference from commercial operations in adjacent spectrum that created problems for public safety users.[23] However, the use of advanced RF engineering techniques in combination with LTE technology can greatly reduce potential interference problems.

A nationwide broadband LTE cellular network based is far less likely then LMR networks to be susceptible to interference may potentially to reduce capacity. Cellular broadband networks are generally interference limited rather than noise limited, so they can tolerate more interference than LMR. Indeed, today's broadband cellular networks are designed to operate at an interference threshold so high that adjacent cells can reuse the same frequencies without causing harmful interference.

Moreover, while significant differences in cell site density also can increase the probability of near-far problems, site density will be more similar for two cellular networks using comparable technology (*e.g.*, LTE) than for a cellular network and LMR system. Furthermore, the number of public safety cell sites recommended in the NBP is roughly consistent with the number of sites currently operated by commercial nationwide wireless providers using spectrum comparable to the 700 MHz band. Thus, if these recommendations are realized and sufficient cell sites are deployed, the anticipated site density of the broadband public safety network will be very similar to that of a 700 MHz commercial network, substantially reducing the risk of near-far problems.

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[22] We note, for example, that commercial broadcasters utilize higher frequency spectrum for mobile Electronic News Gathering operations, which involve different network topologies optimized for high data rate video feeds suitable for HDTV broadcast.

[23] One important reason that adjacent channel interference can more easily become harmful to LMR systems is that LMR systems are noise limited, meaning that radios must operate well even when they receive very weak signal levels. In contrast to LMR networks, commercial cellular networks are designed to operate despite significant interference. Accordingly, LMR-based networks are inherently more vulnerable to interference, including adjacent-channel interference, than commercial networks.

The problem is compounded by differences in the number of cell sites deployed in a given region. The site density of commercial wireless networks is typically much higher than that of public safety LMR networks, as discussed infra. Thus, it is common for an LMR public safety radio to be far from an LMR cell site, receiving a weak signal that is close to the noise floor and close to a commercial cell site that is transmitting in adjacent spectrum. In this case, interference in the public safety spectrum allocation may be raised in the area directly around the commercial cell site, due to a) the presence of high levels of radiated power in out-of-band emissions; and/or b) intermodulation products that fall within the public safety channel; and/or c) in-band emissions that are too strong to be adequately filtered out by the public safety receiver. Thus, a commercial site using adjacent spectrum can create a coverage hole for LMR radios. This is called a "near-far" interference scenario. The larger the difference in site density between the commercial network and the adjacent public safety network, the greater the probability that this form of harmful interference will occur.

As public safety leverages commercial infrastructure and commercial broadband technology, and a sufficient number of sites, near-far issues for public safety will be essentially the same as near-far issues for commercial networks. This means that commercial standards for interference between networks operating in adjacent spectrum will apply to public safety. For example, 3GPP specifications for LTE assume that two adjacent channel LTE networks operated by different wireless providers (i.e., in which sites are not necessarily co-located) would not require an additional guard band, assuming they are each deployed using similar site densities.[24] As a result, spectrum allocations for LTE around the world (*e.g.*, digital dividend allocations in the United Kingdom[25] and Germany[26]) do not include guard bands between adjacent operators.

III. Cost as a Driver for Network Capability

In addition to providing sufficient capacity, the NBP recommendations are designed to provide public safety nationwide interoperable broadband communications in a cost-effective manner. One important way to reduce cost is to maximize the use of commercial technology. If public safety uses commercial-scale components in its devices, they will benefit from commercial economies of scale. This is achieved in part by requiring the D Block licensee, and perhaps other 700 MHz licensees, to offer some devices that are also capable of operating in the public safety band. However, if there is no D Block commercial operator, then there will be no ecosystem of D Block commercial devices. In this situation, the market for Band Class 14 LTE devices, *i.e.* the devices that use either the D Block or PS broadband spectrum, would be far smaller and the costs of public safety devices would be far larger. This same phenomenon would negatively impact the radio access network equipment market. Without one or more commercial operators utilizing equipment that can operate in Band Class 14, it is likely that public safety will not be able to benefit from the commercial economies of scale that are available in the rest of the 700 MHz band.

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[24] Section 5.7.1 of the 3GPP standards on channel spacing provides:

> The spacing between carriers will depend on the deployment scenario, the size of the frequency block available and the channel bandwidths. The nominal channel spacing between two adjacent E-UTRA carriers is defined as following:
>
> $$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2$$
>
> where $BW_{Channel(1)}$ and $BW_{Channel(2)}$ are the channel bandwidths of the two respective E-UTRA carriers. The channel spacing can be adjusted to optimize performance in a particular deployment scenario.

[25] *See* http://www.bis.gov.uk/assets/biscore/corporate/docs/migrated-consultations/digital%20britain%20report-%20a%20consultation%20on%20a%20direction%20to%20ofcom%20to%20implement%20the%20wireless%20radio%20spectrum%20modernisation%20programme.pdf (paragraph 3.33 on page 17 which states that the 800 MHz digital dividend spectrum will be auctioned "in six lots of 2 x 5megahertz").

[26] *See* http://www.cesifo-group.de/pls/guestci/download/CESifo%20DICE%20Report%202010/CESifo%20DICE%20Report%201/2010/dicereport110-db4.pdf (Germany allocated digital dividend spectrum into six 2x5 megahertz blocks).

Another significant cost-saving element of the NBP is the incentive-based partnership approach. Although not required, NBP deployment costs were calculated using this approach, and the savings were considerable when compared to a stand-alone network dedicated to public safety and does not leverage commercial infrastructure. Under the NBP, a $6.5 billion investment could provide coverage to 99% of Americans by enabling construction of a public safety "overlay" network on 41,600 existing commercial sites; hardening of commercial towers; the addition of over 3,000 sites in rural areas; and the development of a fleet of public safety deployables. This is far less expensive than a stand-alone public safety network, which would likely cost at least $15 billion to construct.[27] Moreover, failing to leverage commercial infrastructure would mean that existing commercial networks would not be hardened, making them less reliable for carrying critical infrastructure traffic. The NBP also noted that this hardened infrastructure will better support utilities and facilitate the deployment of energy-efficient smart grid technology.

In sum, incentive based partnerships, where public safety holds full rights to its spectrum but where infrastructure is shared between public safety and commercial systems, provide a more cost effective mechanism for this necessary evolution path. A stand alone system dedicated to public safety would require all evolution costs to be borne by the vastly smaller public safety user base. Moreover, because of the higher cost of the stand-alone approach, the resulting network would probably have fewer cells with much larger cell radii, and the capacity and performance of public safety communications would suffer as a result.

IV. Conclusion

The NBP's recommendations for the deployment of a nationwide interoperable public safety broadband wireless network were developed over the course of almost a year of intense study, inquiry, analysis and meetings with and input from public safety leaders, communications engineers and industry experts. The result is a plan that will provide public safety with a nationwide, interoperable network that has the capacity for all day-to-day operations and with the innovation of public safety roaming and priority access across the 700 MHz cellular spectrum, surge capacity for emergencies, and even extraordinary contingencies.

The network is based on the availability of 10 megahertz of spectrum dedicated to public safety use by Congress, which provides public safety with substantially more spectrum per user than major commercial networks, providing them with the required capacity and performance for critical communications needs. Roaming and priority access will provide additional capacity on up to 70 megahertz or more of spectrum. The NBP recommendations makes full use of the additional capacity that can be gained from use of LTE and IP technology, and public funding to build out a sufficient number of cell sites to support the network.

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[27] *See Cost Model Paper* at Section E.

Appendix

INTRODUCTION

In this Appendix, we analyze public safety use of broadband wireless communications employing a network built in accordance with the FCC Cost Model in 10 megahertz of spectrum in four scenarios depicting various types of emergencies. For each scenario, we calculate the expected value of utilization[28] of the network.[29] We assume for purposes of this analysis an LTE network whose capacity averaged over each sector[30] is 7.5 Mb/s (downlink) and 3.25 Mb/s (uplink). These figures represent average throughput and are in-line with current industry benchmarks.

In addition, while studies of voice communications among present day emergency responders during disaster events have shown that the command and control communication structure used by public safety results in a sparse, highly compact process of communication,[31] our analysis departs from this model to yield a more conservative result. For purposes of analysis we assume that video and data communications are generated by individual responders, mobile vehicles and command centers. Activity levels assumed per device category are greater than or equal to those typically found in the commercial environment. These assumptions produce a rich, video intensive environment in which large amounts of data are continually transmitted by emergency responders.

Our analysis yields the following observations/conclusions:

- LTE networks deployed in accordance with engineering assumptions in the FCC Cost Model, which are themselves consistent with commercial engineering assumptions, provide sufficient capacity to meet the communication needs of public safety utilizing the 10 megahertz of spectrum that has been allocated to public safety for broadband over a broad range of scenarios and assumptions.

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[28] Utilization is the fraction of capacity in use. Utilization must be below 1 to be feasible, and not too close to 1 to avoid congestion problems.

[29] *See* Omnibus Broadband Initiative, A Broadband Network Cost Model: A Basis for Public Funding Essential to Bringing Nationwide Interoperable Communications to First Responders (rel. Apr. 2010) (*Cost Model Paper*), *available at* http://www.fcc.gov/pshs/docs/ps-bb-cost-model.pdf (last visited May 10, 2010).

[30] Each cell site is typically divided into 3 sectors.

[31] *See* Federal Communications Commission, Emergency Communications during the Minneapolis Bridge Disaster: A Technical Case Study of the Federal Communications Commission's Public Safety and Homeland Security Bureau's Communications Systems Analysis Division at 16-17 (2008) (*Minneapolis Bridge Case Study*), *available at* http://www.fcc.gov/pshs/docs/clearinghouse/references/minneapolis-bridge-report.pdf (last visited Apr. 28, 2010).

- Deploying greater numbers of cell sites achieves a greater aggregate capacity and higher overall level of spectral efficiency, consistent with Commission goals to achieve highest use for this scarce resource.

Scenario I and II have been extracted from the New York City Department of Information and Technology's recent filing in FCC Docket 07-114 (*New York City Filing*).[32] Scenario III and IV are based on actual events and empirical data that was collected and analyzed by FCC staff, to include data extracted from FCC reports on these disasters.

Scenario I: Dirty Bomb in New York City

The *New York City Filing* provides one of the few discussions in the record developed for the NBP of the public safety response to a specific emergency scenario, in this case a hypothetical "dirty bomb" attack at Manhattan's Penn Station in the middle of a busy work day.[33] In this scenario, the attack has left 900 people injured, some of whom are in critical condition. With support from the New York City Transit Authority, EMS has been mobilized to assist the injured. In addition, the New York City Police Department has initiated a Level 4 mobilization to deal with the security threat. To contain the broader dangers of the nuclear contaminants unleashed by the dirty bomb attack, the New York City Fire Department has set up a hazardous material (HazMat) detoxification / wash-down.

For purposes of analysis we employed the following assumptions, all of which are taken directly from the *New York City Filing*.[34] In the downlink direction, there are 38 video links active at a time, and 16 Mb/s of non-video traffic, which includes database access, file downloads, telemetry, computer aided dispatch, and VoIP. In the uplink direction, there are 12 simultaneous video links, and 7 Mb/s of non-video traffic which includes 2 Mb/s of triage images from EMS. The locations of emergency responders are uniformly distributed across an area surrounding the incident. (In the *New York City Filing*, this area consists of three sectors.[35])

In addition, we have employed three traffic assumptions in our analysis that differ from those in the analysis reflected in the *New York City Filing*. The first concerns video data rate. As discussed in great depth previously, NPSTC and SAFECOM have indicated that the needs of public safety can be met with per-device data rates of 256 Kb/s and 384 Kb/s respectively.[36] Notwithstanding these assessments, the analysis reflected in the *New York*

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[32] *See* Comments of NYC Department of Information and Technology, FCC Docket 07-114 (received Nov. 17, 2009) (*New York City Filing*).

[33] *See id.*

[34] *See id.* We take no position on the appropriateness of the assumptions reflected therein.

[35] *See id.* at 14.

[36] *See* Public Safety Spectrum Trust, Public/Private Partnership Bidder Information Document at 8 (2007); National Public Safety Telecommunications Council, Public Safety 700 MHz Broadband Statement of Requirements at 39 (2007), *See* Public Safety Statement of Requirements, Vol II, Ver 1.2, Tables 6 and 7 at

City Filing is based on the assumption that public safety will require downlink video at 1.15 Mb/s (essentially standard broadcast quality video) and 647 Kb/s quality uplink video[37]. For the reasons stated, we have rejected this assertion.[38] We do, however, include the non-video traffic assumption reflected in the *New York City Filing* analysis of this scenario.[39]

Second, the sector downlink capacity assumption of 7.5Mb/s (for 10 megahertz), which is the limiting factor in this scenario, is more conservative than that employed in the analysis reflected in the *New York City Filing*. The *New York City Filing* analysis assumes a downlink capacity of 10 Mb/s for 10 megahertz bandwidth and 21 Mb/s for 20 megahertz bandwidth.[40]

Thirdly, our assumptions differ from the analysis reflected in the *New York City Filing* with regard to the number of cell cites deployed. We assume that an appropriate number of cell sites have been deployed, as would be the case under the NBP recommendations. The NBP recommends and the FCC Cost Model assumes that to meet public safety requirements either for capacity or in-door signal-reliability, the number of sites should be significantly increased from the 200 reflected in the *New York City Filing*.[41] Increasing the number of cells would allow each cell to cover a smaller area, increasing overall capacity and spectral efficiency. As a result, where the analysis reflected in the *New York City Filing* assumes that the activities associated with disaster response would be distributed over 3 sectors, we conservatively assume the activities would be distributed over 6 sectors. The FCC Cost Model would result in the deployment of considerably more than 3 times as many cell sites than that reflected in the *New York City Filing* scenario. Therefore 9 or more sectors would cover the area of operation for the dirty bomb as assumed in the *New York City Filing*. As **Exhibit 1** below shows, this emergency would produce a mean utilization of 58% (downlink) of the capacity available in 10 megahertz for a video rate of 256Kb/s.

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http://www.safecomprogram.gov/NR/rdonlyres/2ADCC02F-4665-4D4C-B512-63CE59BD58DB/0/PS_SoR2_v12.pdf (last visited May 10, 2010).

[37] *See New York City Filing* at 23.

[38] *See supra* at Section I(G).

[39] *See New York City Filing* at 24.

[40] See *id.* at 23.

[41] *See id.* at 14.

Public Safety Spectrum Utilization During "Dirty Bomb" Scenario
256 Kb/s video

	Downlink utilization	Uplink utilization
Video	.22	.16
All other applications combined[42]	.36	.36
Total	.58	.52

Exhibit 1

Even with higher-quality video, there is still more than enough capacity in 10 megahertz of spectrum to respond to the dirty bomb attack in Penn Station described in the scenario. **Exhibit 2** shows network utilization below 68% (downlink) for 384 Kb/s video. We also show in **Exhibit 3** the case for 512 Kb/s video with network utilization (downlink) of 79%.[43]

Public Safety Spectrum Utilization During "Dirty Bomb" Scenario
384 Kb/s video

	Downlink utilization	Uplink utilization
Video	.32	.24
All other applications combined	.36	.36
Total	.68	.60

Exhibit 2

Public Safety Spectrum Utilization During "Dirty Bomb" Scenario
512 Kb/s video

	Downlink utilization	Uplink utilization
Video	.43	.32
All other applications combined	.36	.36
Total	.79	.68

Exhibit 3

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[42] Including VoIP, database access, file transfers, telemetry, computer aided dispatch, images transfers, sensors, incident management, and more. *See New York City Paper* at 34-40.

[43] In the *New York City Filing*, downlink utilization for the 200 cell site, 20 megahertz network under this scenario was 95%.

These Exhibits show that deploying a sufficient number of cell sites, in-line with commercial design strategies and the NBP recommendations, increases overall network capacity, improves spectral efficiency and provides sufficient capacity to meet public safety needs for this serious emergency in 10 megahertz of dedicated spectrum utilizing adequate infrastructure and sound spectrum management principles.

Scenario 2: New York City Network Growth needs for Major Urban Environment

In addition to the emergency dirty bomb scenario reflected in the *New York City Filing*, the New York City Department of Information and Technology's ("NYCDIT") estimate of the 12-year operational growth needs for a citywide wireless network provides a second scenario for analysis.[44] This estimate includes communications associated with a variety of municipal functions including public safety and many applications such as video and non-mission critical voice. As described below, we assess the ability of a system built out in 10 megahertz of dedicated spectrum to support this traffic using these projections. For simplicity of comparison, we will use all traffic load assumptions used by NYCDIT in their filing, although the FCC takes no position on the appropriateness of these assumptions.

NYCDIT estimates a network aggregate traffic load of approximately 7.3 Gb/s (downlink) and 3.6 Gb/s (uplink) in Year 12. **Exhibit 4** (Figure 5 from the *New York City Filing*) shows the growth of network traffic plotted against capacity for a 200 site network deployed in 10 megahertz of dedicated spectrum. NYCDIT's figures indicate when aggregate load would reach 75% of capacity.[45]

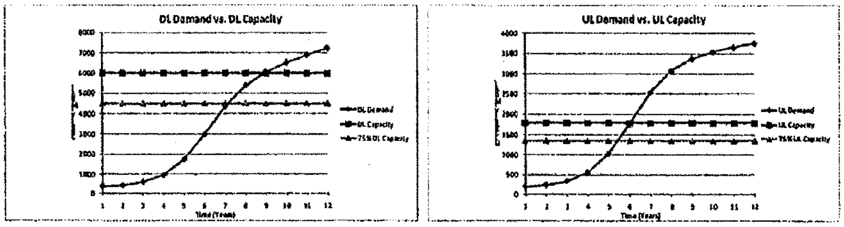

Exhibit 4

Exhibit 5 (Figure 6 from the filing) shows the same growth projection for a 200-site network deployed in 20 megahertz of spectrum:

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[44] *See New York City Filing* at 10.

[45] NYC uses a 75% capacity threshold here as a conservative estimate of effective maximum capacity or a trigger point for capacity expansion.

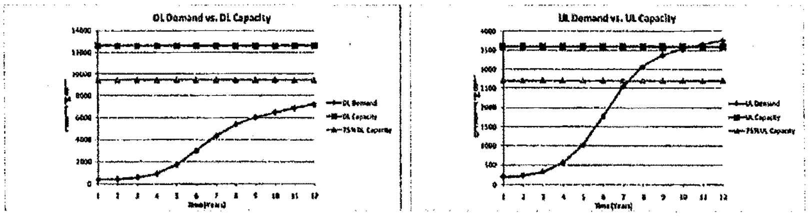

Exhibit 5

NYCDIT summarizes these results in **Exhibit 6** (Tables 2 and 3 from the *New York City Filing*).[46] A review of these tables demonstrates that the uplink channel will be the first to run out of capacity, reaching 75% of capacity in 5.5 years with a 10megahertz allocation, and 7.1 years with a 20 megahertz allocation. Even with 20 megahertz of spectrum proposed by NYCIDT in its estimation, NYCDIT will need to expand the network by year 7 or 8 under these assumptions.

75% Capacity Exceeded	With Voice	Without Voice
Downlink	7 years	7.5 years
Uplink	5.5 years	5.8 years

Table 2 - Capacity with and without Voice with 10 MHz LTE Bandwidth

75% Capacity Exceeded	With Voice	Without Voice
Downlink	> 12 years	>12 years
Uplink	7.1 years	8 years

Table 3 - Capacity with and without Voice with 20 MHz LTE Bandwidth

Exhibit 6

As explained earlier, these network capacity exhaust time intervals are not intrinsic to the spectrum allocated; they depend on many factors, including the number of cell sites deployed. The number of cell sites assumed when deriving the above table is considerably less than would be recommended in the NBP. Indeed, it is just over half the number of sites that NYC has in use today, implying that New York would choose to greatly reduce its infrastructure at a time when the NBP would support expansion.

Based on NYCDIT's growth model, we establish a target network capacity such that at Year 12, network capacity is 75% of total network capacity. As shown in **Exhibit 7**, NYDITC's projected growth to reach 75% network capacity over the next 12 years can be supported within 10 megahertz of spectrum as long as at least approximately 492 cells are deployed, even using the more conservative FCC assumption of 7.5 Mb/s downlink capacity, which is still well below the number of sites that would be provided for based on the methodology employed within the FCC Cost Model. If, for example, NYCDIT were to deploy 750 sites (which is consistent with the NBP and the FCC's cost model planning assumptions), then utilization would not reach 50% within 12 years, as shown in **Exhibit 8** .

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[46] *New York City Filing* at 15.

In sum, by building out sufficient cell sites, even these 12-year traffic projections from NYCDIT can be supported within 10 megahertz of dedicated spectrum with excess capacity to spare. To be more specific, the FCC funding proposal derived from the FCC Cost Model would provide for significantly more capacity within a 10 megahertz allocation of spectrum than the NYCDIT proposed design which minimizes cell site deployment at the expense of spectral efficiency of NYCDIT's proposed 20 megahertz spectrum allocation. This approach of deploying more cell sites to increase capacity and spectral efficiency is consistent with the FCC Cost Model and funding recommendations for a public safety broadband network developed by the FCC.

New York City 12 Year Growth Requirements

	75% Capacity Uplink Cell Sites Required Year 12	**75% Capacity Downlink Cell Sites Required Year 12**
Capacity Required in NYC projection	4.8 Gb/s	9.7 Gb/s
No. Cell Sites Needed with FCC Plan	492	433

Exhibit 7

New York City Utilization after 12 Years with 750 cells

Uplink utilization after 12 years	**Downlink utilization after 12 years**
.49	.43

Exhibit 8

Scenario III: Collapse of the Minneapolis Bridge

The third scenario is based on an actual disaster. At 6:00pm on August 1st, 2007, the Interstate 35 West Bridge collapsed in Minneapolis killing 13 people and injuring 145. Emergency responders reacted quickly. In a little over 2 hours, all survivors from the affected area had been removed. The FCC, with the cooperation of public safety communication officials from Minnesota studied this disaster and issued a report.[47]

As a result of the study certain facts are known which allow us to make certain approximations for purposes of analysis. Nearly all emergency responders in this area shared a common LMR system. This allows us to approximate the number of responders at the scene. We also know that as emergency responders rushed to the incident, the two LMR sites immediately adjacent to the disaster showed a combined increase of approximately 600 unique radio IDs in hour 2 of the disaster, over the baseline of 994 unique radio IDs that were present in the hour preceding the collapse.

We assume that each radio ID represents a single first responder. We assume that a majority of the 994 personnel on duty before the disaster continued their normal function and were randomly scattered throughout the two LMR serving areas, comprising an approximate serving area of 254 square miles. Thus, 600 additional personnel flooded a small area around the site of the disaster, participating in the rescue efforts. We also apportion an additional 40 emergency responders within the emergency area to represent the approximate number of emergency responders that might normally have been within a 10 square mile area of the disaster site and allocated this number to the rescue effort as well. Thus, a total of 640 emergency responders are used to represent the number of responders within the incident area. We vary the area constituting the affected rescue area, first assuming an approximate 10 square mile box that encompassed major highways surrounding the bridge and progressively shrinking the box to 5 sq. miles and then 1 sq. mile. This increases the density of emergency responders in the incident area and increases the traffic load per sector.

In addition to the individual first responders, we consider a scenario in which mobile command centers are on the scene, and are receiving and generating a significant amount of video traffic. The actual amount of video required at the incident scene is, of course, an estimate. As a figure of merit, we take the estimate employed by the NYCDIT in its analysis of the dirty bomb incident of 38 videos down and 12 videos up and apportion this video estimate over a conservative 6 sector[48] area. Thus, within the affected area, each sector supports 6 video links down and 2 video links up.

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[47] *See Minneapolis Bridge Case Study.*

[48] As noted earlier, we estimated a minimum of 9 sectors would cover the equivalent area in the NYC dirty bomb scenario (Scenario I). We assume 6 sectors over which the video traffic will be distributed, rounding the result.

This traffic is designated as Command Unit Uplink and Downlink Video in the traffic model, as shown in **Exhibit 9.**[49] For the command unit video only, we vary the quality of the video from 256 Kb/s to 512 Kb/s. As the model shows, we also assume that some percentage of video, at 256 Kb/s, is generated by emergency responders.

For these scenarios we assume the following traffic model:

Type of application or device	**% of responders carrying device**	**% of time devices transmit**	**Up Link data rate (Kb/s)**	**% of time devices receive**	**Down Link data rate (Kb/s)**
Mobile Video Camera	25%	10%	256	5%	12
Data File Transfer CAD/GIS	87%	15%	50	5%	300
VoIP	100%	5%	27	15%	27
Secure File Transfer	12%	5%	93	5%	93
EMS Patient Tracking	6%	10%	30	5%	50
EMS Data Transfer	6%	25%	20	5%	25
EMS Internet Access	6%	10%	10	5%	90
Command Unit Downlink Video	NA	NA	NA	100%	256, 384, 512
Command Unit Uplink Video	NA	100%	256, 384, 512	100%	256, 384, 512

Exhibit 9

The amount of VoIP traffic in the model is a conservative estimate based on prior analysis of public safety communications.[50] As noted, Command Unit video is derived from the example presented in the *New York City Filing.*[51] The remaining functions are approximations of public safety functions on a broadband network chosen to ensure that each emergency responder will present a network load. In this model, emergency responders are assumed to contribute to the overall video traffic. Assumptions about data rates are taken directly from the *New York City Filing*, PSST Bidder Information Document and the SAFECOM Statement of Requirements (SoR).[52]

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[49] Command Units are specialized vehicles used by emergency responder command staff for incident management and generally equipped with extensive communications equipment.

[50] Data developed during the FCC Report on the Minneapolis Bridge Disaster demonstrated that voice utilization by public safety is very low for LMR radio, less than 3%. To remain conservative, we assume higher utilization rates for this analysis.

[51] *See New York City Filing* at 24 (Nov. 17, 2009).

[52] *See* Public Safety Statement of Requirements, Tables 6 and 7 at http://www.safecomprogram.gov/SAFECOM/library/technology/1258_statementof.htm

See also Public Safety Spectrum Trust Public/Private Partnership Bidder Information Document, Version 2.0, November 30, 2007.

See also New York City Filing at. 7.

Exhibit 10 shows the area of the bridge disaster with a 10 square mile area that encompasses major highways surrounding the bridge. Traffic is modeled in the following manner. As shown in **Exhibit 9,** the average number of responders within a sector is calculated and the traffic load generated by emergency responders under the model is calculated. This is combined with the Command Unit video traffic to provide the traffic per sector to be supported. Finally, the traffic utilization for sector is calculated.

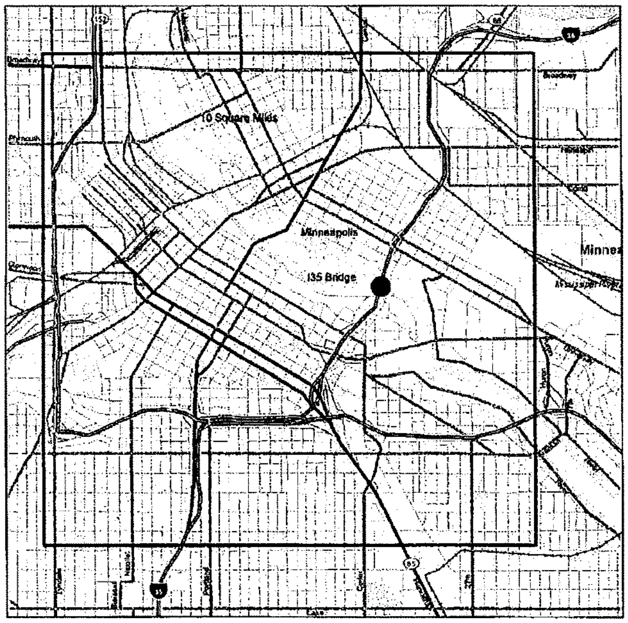

Exhibit 10

Case 1: Responders Operate in 10 Square Mile Area

Responder Area: 10 Square Miles - Sector Utilization

Responders At Scene: 640	**Sectors: 60**	**Responders/Sector: 11**
Type of application or device	**Up Link Load**	**Down Link Load**
Mobile Video Camera	2%	0%
Data File Transfer CAD/GIS	2%	2%
VoIP	1%	1%
Secure File Transfer	0%	0%
EMS Patient Tracking	0%	0%
EMS Data Transfer	0%	0%
EMS Internet Access	0%	0%
Total	5%	3%

Exhibit 11

As can be seen from **Exhibit 11**, with a 10 square mile operating area, the Non-Command Unit traffic has a utilization of only 5% up and 3% down.

	Video Links	**Up Link Load 256 Kb/s**	**Down Link Load 256 Kb/s**	**Up Link Load 384 Kb/s**	**Down Link Load 384 Kb/s**	**Up Link Load 512 Kb/s**	**Down Link Load 512 Kb/s**
Command Unit Downlink	6	0%	20%	0%	31%	0%	41%
Command Unit Uplink	2	16%	0%	24%	0%	32%	0%
	Total	16%	20%	24%	31%	32%	41%
Total Traffic	**Total All**	21%	23%	29%	34%	37%	44%

Exhibit 12

As shown in **Exhibit 12,** a single sector can support 6 downlink video channels and 2 uplink channels and still support a range of other activities with low utilization levels even at video quality as high as 512 Kb/s for Command Unit traffic. The total utilization with 512 Kb/s Command Unit video is 37% (uplink) and 44% (downlink). Thus, this traffic can easily be supported.

Case 2: Responders Operate in 5 Square Mile Area

We next look at the same bridge scenario but with emergency responders operating within a 5 mile area, effectively doubling the density of the population as well as the traffic they generate within the served area, as shown in **Exhibit 13**. We again focus on the traffic utilization for a single sector.

Responder Area: 5 Square Miles - Sector Utilization

Responders At Scene: 640	**Sectors: 31**	**Responders/Sector: 21**
Type of application or device	**Up Link Load**	**Down Link Load**
Mobile Video Camera	4%	0%
Data File Transfer CAD/GIS	4%	4%
VoIP	1%	1%
Secure File Transfer	.5%	0%
EMS Patient Tracking	.25%	0%
EMS Data Transfer	.25%	0%
EMS Internet Access	0%	0%
Total	10%	5%

Exhibit 13

	Video Links	**Up Link Load 256 Kb/s**	**Down Link Load 256 Kb/s**	**Up Link Load 384 Kb/s**	**Down Link Load 384 Kb/s**	**Up Link Load 512 Kb/s**	**Down Link Load 512 Kb/s**
Command Unit Downlink	6	0%	20%	0%	31%	0%	41%
Command Unit Uplink	2	16%	0%	24%	0%	32%	0%
	Total	16%	20%	24%	31%	32%	41%
Total Traffic	**Total All**	26%	25%	34%	36%	42%	46%

Exhibit 14

As can be seen from the results in **Exhibit 14**, compressing the incident area provides more traffic per sector. For example, uplink utilization non-command unit traffic has doubled from 5% to 10%. Total traffic utilization per sector however, even for 512 Kb/s video, remains relatively low at 46% (Down Link). Again, this traffic can be supported.

Case 3: Responders Operate in 1 Square Mile Area

Finally, we examine the scenario where all responders are working within a 1 square mile area. **Exhibit** 15 shows this area overlaid on the bridge location. This represents one of the more serious communication scenarios faced by public safety since such a concentration of resources places a greater burden on any communications system.

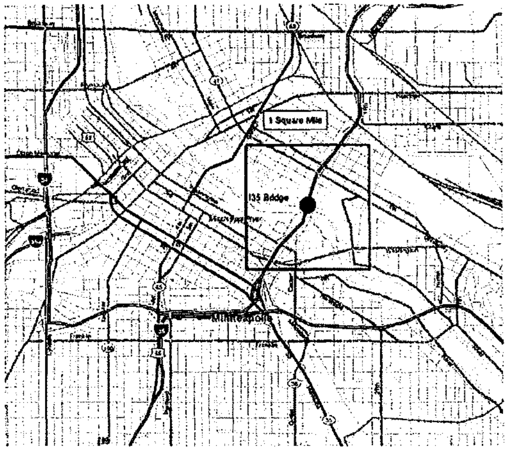

Exhibit 15

Responder Area: 1 Square Mile - Sector Utilization

Responders At Scene: 640	**Sectors: 6**	**Responders/Sector: 107**
Type of application or device	**Up Link Load**	**Down Link Load**
Mobile Video Camera	21%	0%
Data File Transfer CAD/GIS	22%	19%
VoIP	4%	6%
Secure File Transfer	2%	1%
EMS Patient Tracking	1%	0%
EMS Data Transfer	1%	0%
EMS Internet Access	0%	0%
Total	51%	26%

Exhibit 16

	Video Links	Up Link Load 256 Kb/s	Down Link Load 256 Kb/s	Up Link Load 384 Kb/s	Down Link Load 384 Kb/s	Up Link Load 512 Kb/s	Down Link Load 512 Kb/s
Command Unit Downlink	6	0%	20%	0%	31%	0%	41%
Command Unit Uplink	2	16%	0%	24%	0%	32%	0%
	Total:	16%	20%	24%	31%	32%	41%
Total Traffic	**Total All**	67%	46%	75%	57%	83%	67%

Exhibit 17

Exhibit 16 and **Exhibit 17** show that with 107 responders within a sector, full video is maintained, even at a video rate of 512.Kb/s for Command Unit Video. Total uplink utilization is at 83% with command unit video of 512 Kb/s. While this is approaching the practical limits of operation, all video assumed in the scenario is still fully supported. With command unit video at 256Kb/s video, uplink utilization is only 67% and the network has excess capacity. All applications are still supported within the sector.

Local incidents are likely to represent the most extreme communications scenario for a public safety network since responders concentrate within a small area proportionately increasing traffic for that portion of the network. Nevertheless, this analysis demonstrates that there are serious emergencies concentrated within one square mile that can be accommodated with an appropriately built-out network operating in 10 megahertz of dedicated spectrum.

Scenario 4: Hurricane Ike Hits Houston

The fourth scenario is also based on an actual disaster. On Saturday, September 13, 2008, Hurricane Ike struck Texas as a Category 2 hurricane with winds up to 110 mph. Immediately prior to Hurricane Ike's arrival, Galveston Island and other coastal areas were devastated by twenty foot storm surges. Hurricane Ike was extremely large and powerful. At almost 900 miles wide it rolled across the Gulf of Mexico and eventually passed 100 miles to the east of Dallas, Texas. The massive Category 2 hurricane, with winds up to 110 mph at landfall, hit Texas on Saturday, September 13, and became the third hurricane to hit or affect Texas in less than two months. 20-foot storm surges swallowed Galveston Island and other coastal areas just before Ike's arrival and prompted the National Weather Service to later upgrade Ike to a Category 4 hurricane.

The results of our analysis show that in the worst case, the average number of responders per cell site will be 27 and sector utilization will be 18.67% Up Link and 12.9% Down Link. As shown in **Exhibit 18** if 4 times the responders (324 responders) arrived at each cell site, 75% of the Up Link and 51% of the Down Link capacity is utilized – Public Safety communications is still supported.

This analysis, which is based on empirical data that was collected and analyzed by FCC staff, considers the ability of a public safety broadband network to meet average capacity needs in the 14 sites affected in the aftermath of the hurricane, assuming that emergency responders make full use of a variety of broadband applications, including voice and video.[53] At peak of this event, 14,991 unique radios were active throughout these 14 sites. As this analysis shows, if emergency responders were unformally distributed across the county with the most public safety activity, they would consume a mere 18.67% of uplink capacity and 12.9% of downlink on average at the peak of the response. Moreover, even in the extreme case in which the density of Public Safety responders reached four times that level, a cell site would still have a utilization of 75% in the Up Link and 51% in the Down Link direction, which means there would be more than enough capacity available in 10 megahertz.

Capacity Summary - Equivalent PSBB Network to Support Hurricane Ike

	PS Radios at Peak per Cell	PS Radios at Peak per sector	Total Up Stream load	Total Down Stream Load
Uniformly Distributed across Typical PSBB network	81	27	18.67%	12.90%
2x PS Responders at scene	162	54	37.34%	25.46%
4x PS Responders at scene	324	108	74.69%	50.59%

Exhibit 18

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[53] *See Emergency Communications during Hurricane Ike at, http://www.fcc.gov/pshs/docs/clearinghouse/case-studies/Hurricane-Ike-Harris%20County-120109.pdf.*

Exhibit 19 shows the locations of the Harris County Regional Radio System (RRS) tower sites, in relation to the path of Hurricane Ike. The Harris County RRS with 24 sites, presently covers nine counties and supports more than 44,320 users in 243 agencies and 641 departments. Currently, the system covers 9,581 square miles supporting a population of 5,879,458. The Grade of Service (GoS) objective for this system is 2%, meaning that no more than 2% of calls should experience delays exceeding 3 seconds. However, on September 17th, that objective could not be achieved, as traffic levels reached double those that occur in the busiest hour of a typical day. 95% of all the users were served by the 14 LMR sites along or near the path of Hurricane Ike.

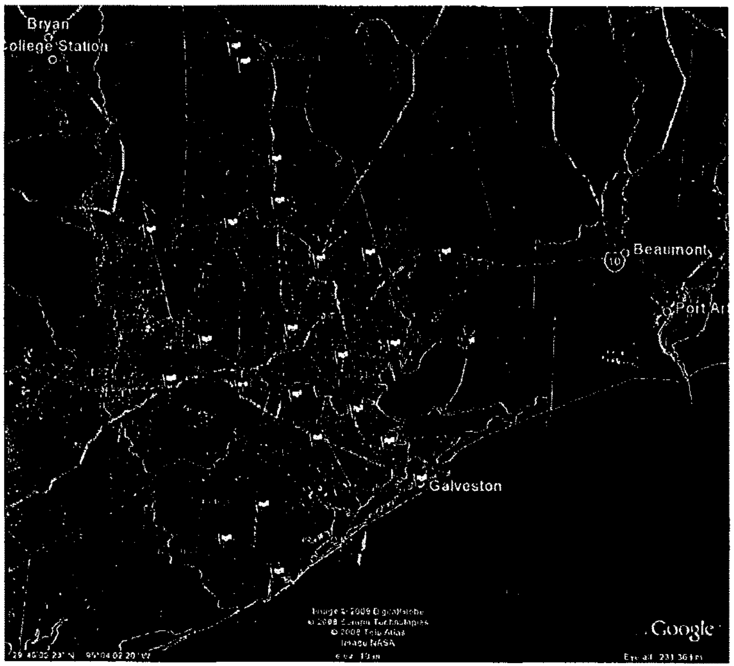

Exhibit 19

Of the 14,991 Public Safety responders dispersed across these 14 Harris County LMR sites during Hurricane Ike, the major radio users were 58% Law Enforcement, 12% Fire Departments, 10% Public Works, 7% Transportation Departments and 6% Emergency Medical Services. The distribution is shown in **Exhibit 20.**

Radio Usage during Hurricane Event - Busiest Day	
Type of Radio User	**Total % of Radio Usage**
Law Enforcement	57.79%
Fire Department	12.26%
Public Works	9.82%
Transportation Departments	7.39%
Emergency Medical Service	6.49%
Communications/Dispatching	2.94%
Security Companies	1.53%
Engineering Departments	0.73%
Elected Officials	0.43%
Parks Departments	0.34%
Probation Departments	0.17%
Legal Departments	0.05%
Admin Administrative	0.03%
Environmental Monitoring and Services	0.02%
Independent School Districts	0.01%
Humane Services	0.01%
Utility	0.00%
Grand Total	**100.00%**

Exhibit 20

As discussed in Section II, a broadband system that reaches 99% of the population with approximately 44,000 cell sites, as recommended in the NBP, would have many more cell sites serving the same area. Cell size depends on many factors, and the FCC model [which one] considers both population density and terrain.[54] **Exhibit 21** shows the number of cells estimated in each county. In the roughly 7,265 square-mile area severely affected by the hurricane, we estimate that 529 sites would be deployed, for a total of 1,278 sectors. As a result, the number of active radios per cell at the peak of the response ranges from 5 in Montgomery County to 81 in hard-hit Brazoria County.

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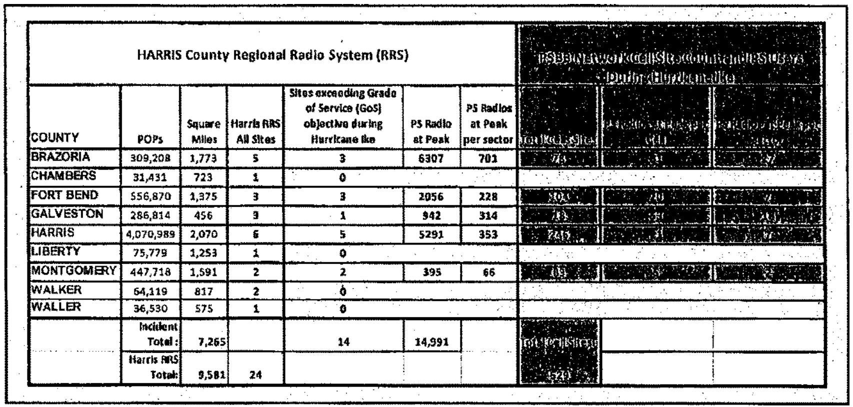
[54] *See Cost Model Paper.*



HARRIS County Regional Radio System (RRS)							[illegible]		
COUNTY	POPs	Square Miles	Harris RRS All Sites	Sites exceeding Grade of Service (GoS) objective during Hurricane Ike	PS Radio at Peak	PS Radios at Peak per sector	[illegible]	[illegible]	[illegible]
BRAZORIA	309,208	1,773	5	3	6307	701	[illegible]	[illegible]	[illegible]
CHAMBERS	31,431	723	1	0					
FORT BEND	556,870	1,375	3	3	2056	228	[illegible]	[illegible]	[illegible]
GALVESTON	286,814	456	3	1	942	314	[illegible]	[illegible]	[illegible]
HARRIS	4,070,989	2,070	6	5	5291	353	[illegible]	[illegible]	[illegible]
LIBERTY	75,779	1,253	1	0					
MONTGOMERY	447,718	1,591	2	2	395	66	[illegible]	[illegible]	[illegible]
WALKER	64,119	817	2	0					
WALLER	36,530	575	1	0					
	Incident Total:	7,265		14	14,991		[illegible]		
	Harris RRS Total:	9,581	24						

Exhibit 21

For this comprehensive analysis, we considered the applications shown in **Exhibit 22.** Assumptions about data rates are taken directly from the *New York City Filing*, PSST Bidder Information Document and the SAFECOM Statement of Requirements (SoR).[55] We assume that Public Safety responders of various types (*e.g.* police, firefighters, and EMS) are distributed evenly across the disaster area, such that the percentages in each region correspond to the overall percentages from the actual event, presented in **Exhibit 20.** Given that the average number of radios per cell was 81 in the worst case discussed above, we consider the case of 81 radios per cell or 27 per sector.

Exhibit 22 is based on the county that was most severely affected by the hurricane, and assumes that responders are uniformly distributed across that county. In reality, the density of responders may be greater in some parts of the county and worse in others. Thus, a busy cell may have two or more times the density of responders. Nevertheless, as shown in the table below, there is ample capacity even if density reaches four times the country-wide average of the busiest county and the busiest time in the aftermath of Hurricane Ike.

The results show a mean utilization of, only 18.67% in the Up Link and 12.9% in the Down Link direction. Therefore, during this extreme disaster in September 2008, when the Harris County RRS encountered an exceedingly high demand for resources, which resulted in a doubling of busy-hour traffic, a public safety broadband network with 10 megahertz of dedicated spectrum could have supported this mission critical event.

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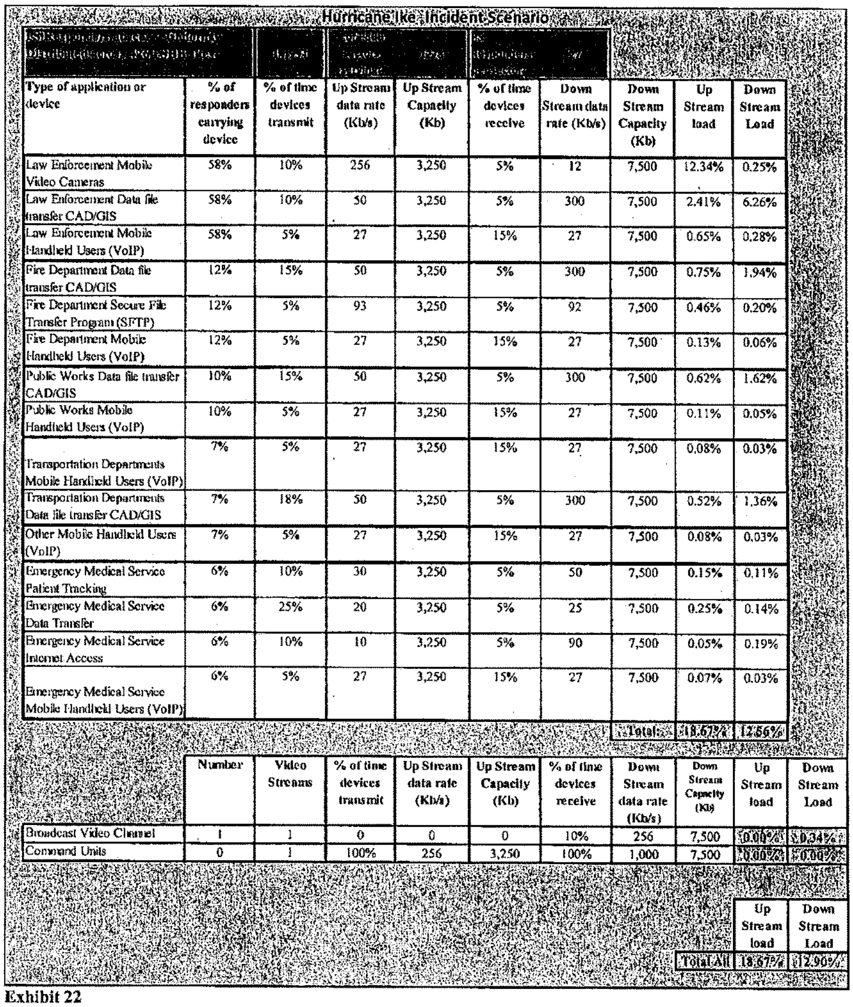
[55] *See id.* The FCC takes no position on the appropriateness of New York City's assumptions.

See also; Public Safety Statement of Requirements, Tables 6 and 7 at http://www.safecomprogram.gov/SAFECOM/library/technology/1258_statementof.htm.

See also; Public Safety Spectrum Trust Public/Private Partnership Bidder Information Document, Version 2.0, November 30, 2007.



Hurricane Ike Incident Scenario

Type of application or device	% of responders carrying device	% of time devices transmit	Up Stream data rate (Kb/s)	Up Stream Capacity (Kb)	% of time devices receive	Down Stream data rate (Kb/s)	Down Stream Capacity (Kb)	Up Stream load	Down Stream Load
Law Enforcement Mobile Video Cameras	58%	10%	256	3,250	5%	12	7,500	12.34%	0.25%
Law Enforcement Data file transfer CAD/GIS	58%	10%	50	3,250	5%	300	7,500	2.41%	6.26%
Law Enforcement Mobile Handheld Users (VoIP)	58%	5%	27	3,250	15%	27	7,500	0.65%	0.28%
Fire Department Data file transfer CAD/GIS	12%	15%	50	3,250	5%	300	7,500	0.75%	1.94%
Fire Department Secure File Transfer Program (SFTP)	12%	5%	93	3,250	5%	92	7,500	0.46%	0.20%
Fire Department Mobile Handheld Users (VoIP)	12%	5%	27	3,250	15%	27	7,500	0.13%	0.06%
Public Works Data file transfer CAD/GIS	10%	15%	50	3,250	5%	300	7,500	0.62%	1.62%
Public Works Mobile Handheld Users (VoIP)	10%	5%	27	3,250	15%	27	7,500	0.11%	0.05%
Transportation Departments Mobile Handheld Users (VoIP)	7%	5%	27	3,250	15%	27	7,500	0.08%	0.03%
Transportation Departments Data file transfer CAD/GIS	7%	18%	50	3,250	5%	300	7,500	0.52%	1.36%
Other Mobile Handheld Users (VoIP)	7%	5%	27	3,250	15%	27	7,500	0.08%	0.03%
Emergency Medical Service Patient Tracking	6%	10%	30	3,250	5%	50	7,500	0.15%	0.11%
Emergency Medical Service Data Transfer	6%	25%	20	3,250	5%	25	7,500	0.25%	0.14%
Emergency Medical Service Internet Access	6%	10%	10	3,250	5%	90	7,500	0.05%	0.19%
Emergency Medical Service Mobile Handheld Users (VoIP)	6%	5%	27	3,250	15%	27	7,500	0.07%	0.03%
							Total:	18.67%	12.56%

	Number	Video Streams	% of time devices transmit	Up Stream data rate (Kb/s)	Up Stream Capacity (Kb)	% of time devices receive	Down Stream data rate (Kb/s)	Down Stream Capacity (Kb)	Up Stream load	Down Stream Load
Broadcast Video Channel	1	1	0	0	0	10%	256	7,500	0.00%	0.34%
Command Units	0	1	100%	256	3,250	100%	1,000	7,500	0.00%	0.00%

	Up Stream load	Down Stream Load
Total All	18.67%	12.90%

Exhibit 22

Mr. WALDEN. Actually, let's go into the work session now, and we will move on through.

We appreciate all your testimony and comments. We will continue to work on these drafts in a quest to find a bipartisan solution for our public safety friends and for all Americans.

With that, we are adjourned.

[Whereupon, at 10:53 a.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

Statement of the Honorable Fred Upton

Chairman, Energy and Commerce Committee

Subcommittee on Communications and Technology Legislative Hearing to Address Spectrum and Public Safety Issues

July 15, 2011

Good spectrum policy can help bring interoperable broadband communications to First Responders, advance commercial wireless broadband service, reduce the deficit, and create jobs. Despite differences with the minority on some of these issues, Chairman Walden and our committee staff have worked to continue the bipartisan efforts we began last Congress on spectrum issues. Today's discussion draft represents what we believe to be a solid base for achieving the goals we all share.

I want to thank my Democratic colleagues, particularly Ms. Eshoo, for working in good faith to find common ground. I hope we can reach agreement; unfortunately, we are not there quite yet. After reviewing the draft circulated by the Ranking Members, I am surprised to see some of the things we differ on. Last year, the FCC, 9/11 Commission Chairman Kean, Vice Chairman Hamilton, and Commissioner Gorton all agreed that our public safety and spectrum goals were best met by auctioning the D-block and using spectrum auction proceeds to help build the nationwide, interoperable public safety network. Mr. Waxman championed a bipartisan discussion draft last Congress reflecting that policy. And so it is that consensus to auction the D-block from which we began this year. I understand some members of the minority are reconsidering their position, but our starting point ought to be the policy on which we last agreed.

We also seem to differ this year on how the public safety network should be governed. I will say from the outset that I am skeptical about the idea of creating a large, federal bureaucracy to manage this network when we would largely be duplicating the systems and expertise already in place in the commercial, government and public safety communities.

Given the incredible value of spectrum to the country both as an asset and as an economic engine, I urge my Democrat colleagues to work with us to produce the solutions that will maximize spectrum use, jobs, and federal revenue while minimizing Federal expenditures.

I thank the witnesses for being here today and look forward to today's testimony.

Statement of Rep. Ed Towns (NY-10)
before the US House Of Representatives
Committee on Energy and Commerce
Subcommittee on Communications and Technology

"Legislative Hearing to Address Spectrum and Public Safety Issues"

Wednesday, July 15, 2011, at 9:00am in 2123

Thank you, Chairman Walden and Ranking Member Eshoo. I am very pleased that the Sub Committee is holding this legislative hearing. It is very important to get the full perspective on the various approaches to spectrum so we can move forward on legislation to address this issue. I want to applaud my colleagues for coming this far and presenting the various legislative options we have so far. I pledge to work in a bipartisan manner to try to get a bill that both sides can support. I am pleased that we will be able to hear from experts about the proposals we have before us. We need to know how these approaches will affect industry and consumers before moving forward.

I am a strong supporter of President Obama's goal of improving the way this country uses its spectrum and freeing up more for mobile broadband and a national public safety network. Incentive auction authority is an efficient tool to put spectrum in the hands of those companies that most want it to roll out the latest most innovative devices our families will rely on in the future. It is critically important that the FCC, given its deep expertise in conducting high quality auction, be given wide discretion in how it is designed and implemented. I remain convinced that the spectrum set aside for a interoperable public safety network be reallocated as it was in the senate bill and as President Obama has recommended. This is a critical national security imperative and much like the Department of Defense handles their needs can be structured to efficiently roll out across the nation with industry participation. Once the rules and governance are in place the build can begin.

I am encouraged by the energy of the high tech community and the response from the broadcasting community to see this through. My constituents still rely on free over the air television, and mobile broadcasting has shown particular promise in disaster situations. I am concerned that opportunities for smaller and minority focused broadcasting may be hurt if the smaller broadcasters are first to take advantage of the incentive auctions. However, the need for spectrum for mobile broadband by ever more users is undeniable, as FCC data has shown.

Again, I thank the Subcommittee and my colleagues for putting forth these proposals and gathering feedback. I look forward to working with my colleagues on these and other issues as we move forward in this Congress.

Thank you and I yield back the balance of my time.

A BROADBAND NETWORK COST MODEL:

A BASIS FOR PUBLIC FUNDING ESSENTIAL TO BRINGING NATIONWIDE INTEROPERABLE COMMUNICATIONS TO AMERICA'S FIRST RESPONDERS

OBI TECHNICAL PAPER NO. 2

EXECUTIVE SUMMARY

In March 2010, the FCC released its National Broadband Plan (NBP), which made significant recommendations for improving access to broadband communications across America and for enhancing the role of broadband in public safety and emergency response. In particular, the NBP proposed a comprehensive strategy for creating a nationwide interoperable public safety broadband wireless network ("public safety broadband network") for first responders and other public safety personnel. This strategy includes:

- Creating an administrative system that ensures access to sufficient capacity on a day-to-day and emergency basis;
- Ensuring there is a mechanism in place to promote interoperability and operability of the network; and
- Establishing a funding mechanism to ensure the network is deployed throughout the United States and has necessary coverage, resiliency and redundancy.

In this paper, the Omnibus Broadband Initiative (OBI) provides support for the NBP's public funding recommendations for the nationwide interoperable public safety broadband wireless network. This paper also explains how public safety agencies can leverage the deployment of 4G commercial wireless networks to greatly reduce the overall costs of constructing their nationwide broadband network.

INTRODUCTION

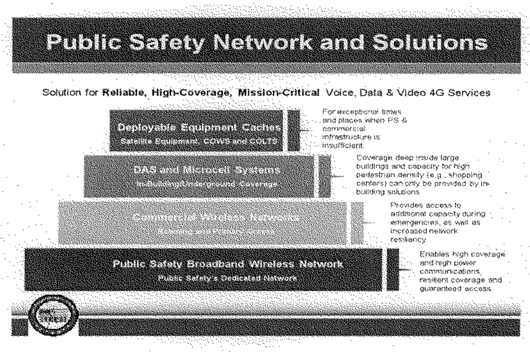
The NBP's vision is to create a communications system that allows public safety agencies to take full advantage of cutting-edge broadband technologies. It is therefore essential that public safety agencies have access to commercial technologies, ruggedized for public safety use. This leveraging of commercial technologies will enable public safety agencies to achieve greater communications capabilities, but at much lower costs.

The NBP's vision for the future of public safety broadband communications encompasses several elements:

As shown in Exhibit 1, a multi-pronged approach will provide public safety with greater dependability, capacity and cost savings. First, the hardened network will provide reliable service throughout a wide area. Second, since emergency responders will be able to roam on commercial networks, capacity and resiliency will improve (at a reasonable cost). Third, localized coverage will improve through the use of fixed microcells and distributed antenna systems (DAS)—like those that provide indoor coverage in skyscrapers. Fourth, equipment can be retrieved from caches and used during a disaster when infrastructure is destroyed, insufficient or unavailable, and fire trucks, police cars and ambulances can become mobile picocells.[1]

The NBP requests total public funding to support the construction and on-going costs of the public safety broadband network. The total present value of the capital expenses and ongoing costs for the network over the next 10 years is approximately $12-16 billion. State and local governments could contribute funds to cover some of these costs, and there may be additional cost-saving methods that reduce this estimate—such as sharing federal infrastructure, working with utilities or use of state and local tower sites.

Exhibit 1:
The Future of Public Safety Broadband Communications


Public Safety Network and Solutions
Solution for **Reliable, High-Coverage, Mission-Critical** Voice, Data & Video 4G Services
Deployable Equipment Caches
Satellite Equipment, COWS and COLTS
For exceptional times and places when PS & commercial infrastructure is insufficient.
DAS and Microcell Systems
In-Building/Underground Coverage
Coverage deep inside large buildings and capacity for high pedestrian density (e.g., shopping centers) can only be provided by in-building solutions
Commercial Wireless Networks
Roaming and Priority Access
Provides access to additional capacity during emergencies, as well as increased network resiliency
Public Safety Broadband Wireless Network
Public Safety's Dedicated Network
Enables high coverage and high power communications, resilient coverage and guaranteed access

The NBP proposes the creation of a public funding program of as much as $6.5 billion capital expenses (capex) in constructing the public safety broadband network. Public funding will be targeted at constructing a public safety overlay network that exploits existing commercial and public safety narrowband infrastructure, as well as: expanding rural coverage; strengthening existing infrastructure; and developing an inventory of deployable equipment. To ensure interoperability, the funding agency should condition all funding awards on compliance with Emergency Response Interoperability Center's (ERIC) requirements.

The public funding program is designed to achieve nationwide interoperability while preserving a great deal of local flexibility. Although ERIC will set common standards and practices for the nationwide network, public safety agencies at the regional or local level may issue Requests for Proposal (RFPs) and then voluntarily enter into contract with the commercial partners of their choice. This approach will empower each region or locality to satisfy its unique communications needs while promoting vigorous competition among commercial operators and systems integrators for public safety customers.

The NBP also suggests a public funding method, such as imposing a minimal public safety fee on all broadband users, to fund the network's ongoing costs, which include operating expenses (opex) and appropriate network improvement costs. The public funding agency should be charged with disbursing these funds, and any use of such funds must contribute to the operation or evolution of the network and comply with ERIC requirements.

The cost model the NBP used to calculate capital expenses and ongoing costs for the network and to inform its recommendation for the public funding program was validated through multiple approaches.[2] First, a detailed radio frequency (RF) model was constructed, and its RF assumptions were validated through a technical analysis that used data acquired from several major commercial service providers, their competitors and vendors. Costs were based on appropriate comparables, including tariff rates, actual proposals from service providers for similar network builds and operations, and information obtained directly from service providers, equipment vendors, and integrators. Detailed cost scenarios were also developed—and compared with cost scenarios provided by service providers and equipment vendors—to further validate costs.[3]

ASSUMPTIONS

The NBP's proposal for a public safety public funding program is designed pragmatically to ensure achievement of high-quality public safety broadband wireless service. The planned network focuses on data and video service initially. Over time, it will support wireless voice services used routinely by first responders, and eventually the specialized voice services provided to first responders via the land mobile radio (LMR) service today. The model assumes data and video services via IP transport in the early years, evolving to the target of interoperable mission-critical voice, data and video IP networks and applications in the long term, supported by necessary innovations for mission-critical service.

An incentive-based partnership model is assumed for the estimates, (except under Section E), under which public safety network operators will partner with commercial operators or systems integrators to construct and operate the network using the 10 megahertz of 700 MHz public safety broadband spectrum. Under this model, the vast majority of sites will be built by a commercial partner, either a wireless operator, equipment vendor or a system integrator. The model assumes a 700 MHz Long-Term Evolution (LTE) network. Costs include installing and operating the dedicated 700 MHz Radio Access Network (RAN) and sharing back-haul and IP core transport systems, including ancillary and support systems and services. The IP network architecture enables public safety agencies to have their own dedicated servers for applications and services requiring high levels of security and privacy. The projected costs are not discounted for competitive bidding dynamics, such as strategic value to RFP respondents.[4]

The model assumes that the 10 megahertz of 700 MHz public safety broadband spectrum will be "lit" using LTE technology by exploiting commercial infrastructure, which would result in significant cost and operating efficiencies. LTE commercial rollout is planned with availability to 95% of the United States population by 2015.[5] The public safety capability will be added to this network with targeted site upgrades. The network will be built to support standard commercial devices that operate at low power levels of 23 dBm (decibels of the measured power to 1 milliwatt). In-building penetration loss assumptions are assumed for the non-rural population areas. Public safety will then be able to achieve better coverage and performance than commercial systems by using higher-gain devices with specialized antennas. For highly rural areas, the cost model assumes deployment of a network to support vehicular coverage with externally mounted antennas (EMA) to achieve 99% population coverage.[6] Cell sites in highly rural areas are accounted for as a blend of sites built on existing structures and new sites. Hardening for all sites is also accounted for in the model,[7] and the model further assumes that deployable caches of equipment will be available for emergency use.[8]

Ongoing costs were also calculated on the basis of an incentive-based partnership model. This model assumes that backhaul, core network, managed IP services and ancillary services will be paid through an operating expense charged through a managed service fee. This managed service fee is based on the existing air card managed service fee structure—with the radio access network (RAN) share of the service eliminated, since public safety partners will be using their own spectrum for their primary service.[9]

There are several factors that result in lower capacity requirements for the core network. These include roaming on commercial wireless networks, priority wireless service on commercial broadband 700 MHz networks, deployables (*e.g.*, next generation cells on wheels (COWS) and cells on light trucks (COLTS)) and in-building supplementation, which provide resiliency for capacity surges, increased coverage and increased redundancy.

CAPITAL EXPENSES (CAPEX)

As much as $6.5 billion in capital funding will be required over a 10-year period to provide advanced public safety broadband network capabilities to agencies that collectively serve 99% of all Americans.

The 10-year estimate of $6.5 billion in capex was developed based on the following assumptions (see Exhibit 2):

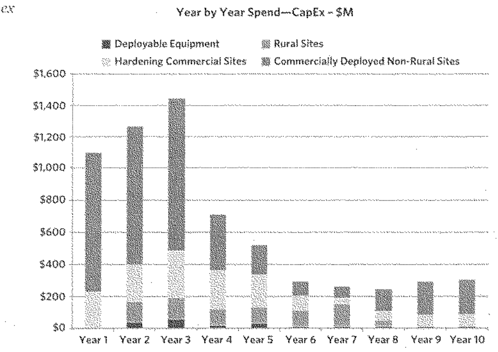
- ➤ $4.0 billion to equip 41,600 commercial towers with dedicated public safety broadband spectrum RAN capabilities;
- ➤ $1.5 billion to harden the commercial towers (improving reliability, particularly when commercial power is lost);
- ➤ $0.8 billion to equip 3,200 rural towers with public safety broadband spectrum RAN capabilities by upgrading towers (75%) and installing and equipping new towers (25%) and hardening those towers; and
- ➤ $0.2 billion to provide for a fleet of public safety deployables (a mix of next generation COWS, COLTS, etc.), vehicular area network systems and non-recurring engineering costs for handset development.[10]

Based on this model, a reasonable year-by-year projection of capital expenses is depicted in Exhibit 3.[11]

Exhibit 2: Capex Chart

Item	Cost	Notes
41,600 Commercially Deployed Non-rural Sites	$4.0 B	Excludes hardening costs Ethernet over fiber backhaul connectivity to commercial carrier's backhaul Assumes PS RAN (lit) added to 100% of sites (conservative)
Hardening of Existing Commercial Sites	$1.5 B	Assumes 100% of sites need hardening (conservative)
3,200 Rural Sites (includes hardening)	$0.8 B	Assumes EMA, blend of 25% new and 75% upgraded sites
Deployable Equipment and Development	$0.2 B	COLTS, COWS, vehicular area Distributed systems , NRE for handset development, etc.
TOTAL CAPEX	**$6.5 B**	

Exhibit 3: Annual Capex Projection



ONGOING COSTS

As previously noted, public funding, such as broadband user fees, will fund the ongoing costs of the network and the network evolution.[12] Following a ramp-up coinciding with the network's expansion, the cost of funding operating costs will reach approximately $1.3 billion per year by the 10th year of construction. The $1.3 billion figure was arrived at on the basis of the following assumptions (see Exhibit 4):

- ➤ $0.9 billion for IP Managed Services and Transport including backhaul and core from commercial operators exclusive of opex for the public safety RAN;
- ➤ $0.2 billion for Managed Services for the dedicated public safety RAN;
- ➤ $0.2 billion for additional ongoing costs for rural areas (microwave backhaul, additional site lease cost, etc.); and
- ➤ $0.025 billion for operations support for deployable equipment.

In addition, the Plan suggests that this fund be reviewed on a regular basis. Part of this review should also consider whether additional funding is required for network upgrades.

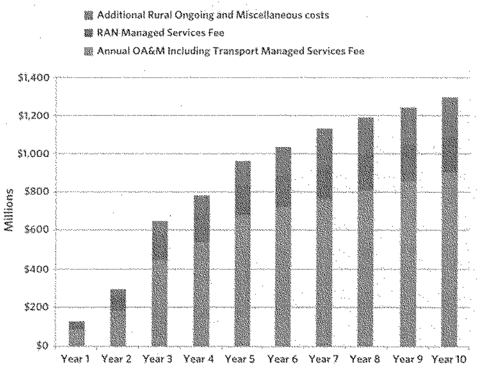
COST OF SEPARATE PUBLIC SAFETY NETWORK

In this section, we compare costs incurred with an incentive-based partnership as described in Section B and costs incurred when an entirely separate dedicated system (stand-alone network) is built for public safety. While the cost estimates for the incentive-based partnership are based on extensive analysis, the costs of the stand-alone network described here are less detailed, in part because of the potential range of ongoing costs. The comparative analysis results in a $6.3 billion capital cost for the network under the incentive-based partnership approach as compared to a $15.7 billion capital cost for a stand-alone public safety network. The cost comparison for these two approaches for both capital and operating costs is even more extreme.

Exhibit 4:
Ongoing Network Costs Chart

Item	Cost	Notes
Annual OA&M Including Transport Managed Services Fee	$0.9 B	For 3 million Public Safety Subscribers at $25 per month
Annual RAN Managed Services Fee	$0.2 B	44,800 Sites at $1500 per year for site equipment, OA&M, and $2400 for additional lease cost (this achieves a 99% population coverage)
Additional costs in rural areas (microwave backhaul, additional site lease costs, deployable OpEx)	$0.2 B	Microwave antenna, power and maintenance lease; miscellaneous ongoing costs
TOTAL ONGOING COSTS	**$1.3 B**	

Exhibit 5:
Ongoing Costs - Ramp Up (EXAMPLE)



The technical requirements and capabilities under both approaches are identical and consistent with the assumptions of this paper. Thus, the total number of cell sites remains 44,800.[13] In an incentive-based partnership, we must consider the marginal cost of adding a new radio access network for public safety to an existing tower or site, which already has backhaul to a functioning core network. While it may be necessary to harden the tower or site, many functions can be leveraged. In contrast, for a stand-alone network, we must estimate the full cost for public safety capabilities rather than just incremental costs. The differences emerge in the cost per cell site in both capex and opex; the costs in zoning and site acquisition, because of the need for many more new cell sites beyond the base required for public safety LMR networks; the costs of backhaul from the cell sites; and the costs for a core network.

In this analysis, we considered the complexity and scope of constructing a nationwide stand-alone public safety network, in which 80% of the 44,800 sites would be new builds. To avoid comprehensive due diligence requirements and to reduce development costs and time to market, wireless carriers and public safety agencies generally prefer to locate on existing structures rather than build new towers. However, public safety sites must be suitable from a zoning perspective. In many jurisdictions, especially in suburban and rural areas, towers are allowed only on commercially or industrially zoned parcels. Some areas allow towers at agriculturally zoned locations, but most do not allow towers on residentially zoned land, forest land or restricted areas. In addition, sites must not have conditions—such as rocky soil conditions, wetlands, impenetrable trees, possible hazardous waste on properties, high voltage power lines and significant distance to the cell tower site from the main road where utilities are located—that would make constructing a tower extremely expensive. Landowners must also be willing to lease sites at acceptable rates.

Therefore, we assumed that, in urban areas, there are many different antenna sites, such as roof top locations, that public safety agencies can leverage. In suburban and rural America, however, new site acquisition, zoning and construction will in general be substantively higher.

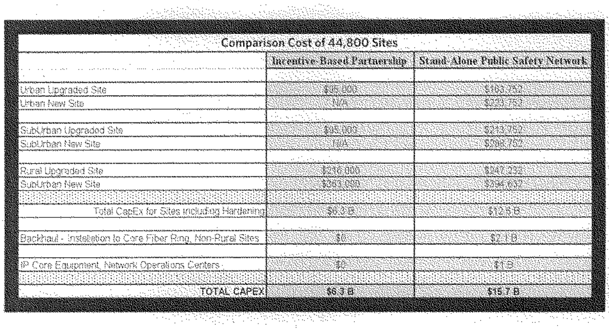
Our analysis indicates that a stand-alone public safety network would be substantially more expensive than a network constructed under the incentive-based partnership approach. Conservatively, the stand-alone network would require at least 2.5 times more capex, excluding deployable equipment, and proportionally even more in ongoing costs.[14] The total present value of the capital expenses and ongoing costs for the stand-alone network over the next 10 years is approximately $34.4 billion, taking into consideration that capex is $15.7 billion and ongoing costs are 1.5 times the total capex amount.[15] This analysis is consistent with both the Verizon study for the Southern Governors Association, which posited $19 billion for initial capex and total costs of $61 billion over 10 years for capex and ongoing operations,[16] and publicly available information about the costs of New York City NYCWiN broadband network.[17] These results are not surprising given that the incentive-based partnership approach leverages the commercial assets of cellular firms that have large economies of scale by serving 40-100 million customers. By contrast a separate public safety network would not be able to leverage the same assets nor have the same economies of scale, since it would effectively serve only a few million first responders while providing similar nationwide coverage. Further, a separate public safety network does not have similar economies of scope, such as sharing an IP core network with other uses.

This lack of scope is compounded if the public safety entity is operating on an LTE network that utilizes spectrum in a band class assigned exclusively for the public safety community. This would be the case if the D block was reallocated to public safety. In that situation, there would be no commercial service provider in LTE Band Class 14 in the 700 MHz band. While technically such a system could be deployed and supported, the costs of the network equipment, most notably the devices, would increase substantially. Without the ability to leverage the economies of scale of a commercial deployment in a band class, there is significantly less market incentive to develop network equipment and devices capable of operating in that band. Therefore, public safety would have to pay significant premiums for equipment and devices under such a scenario.

Exhibit 6 compares the costs of these two approaches. Overall, the partnership reduces capex and opex by at least 60%.

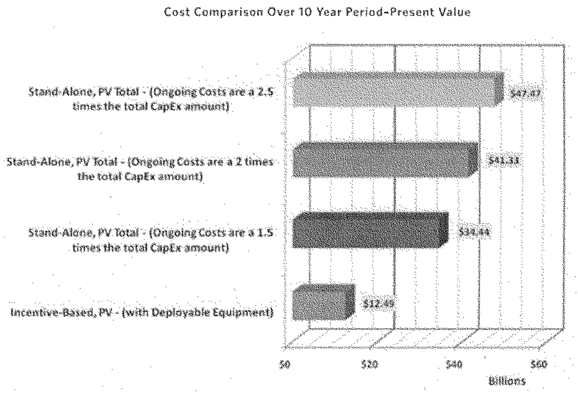
Exhibit 7 provides a cost comparison over a 10-year period for capital and on-going expenses. It shows that the total present value of the capital expenses and ongoing costs for the stand-alone network over the next 10 years would be approximately $41.3 billion or $47.5 billion—with capex at $15.7 billion and ongoing costs at either two or 2.5 times the total capex amount.[18]

Exhibit 6:
Incentive-Based Partnership vs. Stand-Alone Public Safety Network Capital Expenses



Comparison Cost of 44,800 Sites		
	Incentive-Based Partnership	**Stand-Alone Public Safety Network**
Urban Upgraded Site	$95,000	$163,752
Urban New Site	N/A	$223,752
SubUrban Upgraded Site	$95,000	$213,752
SubUrban New Site	N/A	$298,752
Rural Upgraded Site	$216,000	$247,232
SubUrban New Site	$263,000	$394,632
Total CapEx for Sites including Hardening	$6.3 B	$12.6 B
Backhaul - Installation to Core Fiber Ring, Non-Rural Sites	$0	$2.1 B
IP Core Equipment, Network Operations Centers	$0	$1 B
TOTAL CAPEX	$6.3 B	$15.7 B

Exhibit 7:
Present Value Cost Comparison



Cost Comparison Over 10 Year Period–Present Value

APPENDIX A: DEPLOYABLE EQUIPMENT

The public funding program includes funding for two distinct use cases of public safety deployables:

1. Rapidly deployable full cellular systems that can be deployed for public safety use when either:
    a) A natural disaster or other emergency has occurred in a remote area where there is no public safety 700 MHz cellular system (*e.g.*, a train crash with chemical spills in a remote area or a forest fire in a wilderness area); or
    b) The working public safety cellular system for a cell site or larger area has been destroyed or is temporarily inadequate. The systems deployed in such circumstances are sometimes referred to as Cells on Wheels (COWs) and Cells on Light Trucks (COLTs). LTE enables a new generation of this equipment that will be much lighter than current equipment.[19]
2. Vehicles equipped with technology that enables the first responder occupants of the vehicle to use the vehicle communications systems as a relay connecting their handheld to a remote base station. When the officer leaves the vehicle to go into a building or to the physical site of accident (*e.g.*, to investigate a car rolled over an embankment or to pursue a suspect on foot), the handheld device communicates back to the vehicle, which in turn relays the communications back to the closest cellular tower—which may be reachable only from a high-gain vehicle. In effect, the vehicle becomes a vehicular area network (VAN).

The deployable caches included in the public funding will serve all major metropolitan areas and will include sufficient fleets for each state to ensure adequate deployment to reach any emergency within a small number of hours.

This part of the public funding program also includes money for Non-Recurring Engineering costs for the specialized chipset and software development to enable the development of public safety LTE devices in the market that take advantage of commercial capabilities and also ensure the development of any specialized needs for public safety devices. For example, public safety devices must operate in Band Class 14 and be able to roam into other LTE 700 MHz band classes.

APPENDIX B: NETWORK COST MODEL ASSUMPTIONS

- Network Build Model:
  - A pragmatic approach that achieves high quality wireless broadband service using spectrum dedicated for public safety—the 5+5 MHz public safety broadband spectrum—to provide public safety with a dedicated Radio Access Network (RAN).
  - Assumes that public safety agencies on an area-by-area basis will collectively issue a Request for Proposal (RFP) for that area for the building out of the public safety broadband network.

- Potential partners: The respondents to the RFP may include any of the following:
  - A commercial wireless operator with an existing network, particularly a Long Term Evolution (LTE) network in the geographic area with 700 MHz spectrum (other than the D Block) that adds equipment to "light-up" the public safety broadband spectrum;
  - A commercial wireless operator who is a D Block auction winner and is simultaneously building out the LTE Band 14 profile that includes both D Block and public safety spectrum; or
  - A systems integrator who is participating by itself or building out as part of an Land Mobile Radio (LMR) or other build for public safety that builds a broadband wireless network only for the public safety broadband spectrum.
  - The lowest-cost build would be the synchronous build with the D Block, while the highest cost build would be a stand-alone build by a systems integrator.

- Funding is based on an asynchronous build where existing operators' infrastructure would be expanded to include the "lighting" of the public safety 700 MHz broadband spectrum to give public safety a dedicated RAN.
  - Assumes LTE commercial rollout availability to 95% of the population will be achieved by market forces by 2015.
  - For the 95% that are likely to be served by LTE-based operator plans, this would be an asynchronous expansion by an operator who has built out an LTE network.
  - For highly rural America, where there is not market commitment for an LTE network, build out was modeled to use 2G infrastructure plus new towers where necessary.

- Subscriber device model:
  - Commercial power levels (23 dBm) for handheld devices, except in highly-rural areas. Public safety agencies can choose to equip their officers with slightly larger handheld devices with small external antennas and larger batteries, thus gaining 2 to 3 decibels (dBs) of additional power. These devices will provide public safety officers with superior coverage and high speed near cell edges.
  - In highly rural areas the subscriber device supported by the network is a vehicular device using an externally mounted antenna (EMA). Commercial handheld devices will also work in these areas for much of the area within a cell site, but at reduced speeds as one gets closer to the cell edge.
  - The model contains no device funding for handheld or the vehicular device with the EMA, as that was assumed to be the responsibility of each individual agency.
  - The subscriber devices should be substantially lower in costs than they are today for public safety because of the ability to leverage the commercial device ecosystems. In the operating system, the baseband chipset and the RF chipset are the components of the device that require high volumes to drive costs down. These components will also be used in commercial deployments and thus will be in high volume.

- Network services:
  - Data and video services via IP Transport in early years offering a more reliable, high performance, and more cost-effective version of the commercial wireless aircard services that some public safety officers purchase today.
  - Commercial voice via VoIP over LTE in the medium term as that becomes available on LTE networks.
  - Interoperable, mission-critical voice, data and video IP networks and applications as the long-term target.

- Link budget assumptions:
  - In-building penetration loss assumptions are the same as commercial LTE except for highly-rural, which is modeled for vehicular EMA coverage. As noted above, public safety officers can achieve performance superior to commercial performance with handhelds with small external antennas.
  - LTE Commercial Speeds with 95% area coverage (256 Kbps uplink typically) can be achieved on top of an LTE commercial service cell site infrastructure with minimal site supplementation.
  - Vehicular coverage for highly rural areas to achieve 99% population coverage.

- Grant funding:
  - Public funding for paying for the RFPs is based on a commercial winning bidder installing and operating a dedicated public safety broadband 700 MHz RAN that shares backhaul, IP Core transport systems, including ancillary and support systems and services. Public safety agencies may choose to operate dedicated servers for specific applications and services that contain sensitive information.
  - Funding is based on the full costs of dedicated RAN build. There is no discount of the prices included for competitive bidding dynamics, such as strategic value to RFP respondents, although such discounts are likely.

- Operating expense assumptions:
  - Backhaul, core network and managed IP services and ancillary services provided via wireless operator or systems integrator and paid through opex charged for a managed services fee.
  - Managed service fee based on 2010 aircard managed service fee structure with RAN share of service eliminated.
  - Annual opex fee incurred for management and maintenance of public safety broadband 700 MHz RAN.

- Capital expense assumptions:
  - Cell sites in rural America are treated as a blended build of new sites on existing structures and new sites.
  - $95,000 blended average per site capex for adding public safety broadband to commercial LTE cell site.
  - $35,000 hardening per site for commercial LTE sites.
  - $216,000 average per site capex for adding public safety broadband to existing sites in most rural areas, including $75,000 per site for hardening.
  - $363,000 average per site capex for public safety broadband new sites in the most rural areas, including $75,000 per site for hardening.
  - Priority wireless service on commercial networks, deployables and in-building supplementation provides for capacity surges, more extensive coverage and more resiliency, thus lowering site requirements on the core network.
- The model will be refined based on real-life experience in future public funding years.

APPENDIX C: UNDERLYING EQUIPMENT AND COST FOR CAPITAL EXPENSE ASSUMPTIONS

EQUIPMENT AND COSTS FOR BLENDED AVERAGE PER SITE CAPEX FOR ADDING PUBLIC SAFETY BROADBAND TO COMMERCIAL LTE CELL SITES.

Non-Rural Site Configuration A and B, for Asynchronous Build

Two different types of configurations (A and B) are used for the underlying equipment for adding public safety broadband to commercial LTE cell sites. In addition, structure heights, or distances from the eNodeB to Antennas for the site locations, were evaluated for cost at 75 feet and 150 feet. The main differences between configuration A and B are that configuration A uses rigid coax and configuration B uses fiber and remote radio heads (RRH). Configuration A uses rigid coax from the eNodeB at the base of the structure/tower up to the top of the tower or structure/tower where the antennas are located. Configuration B uses fiber from the eNodeB at the base of the structure/tower up to the top of the tower or structure/tower where the antennas and RRH are located.

EQUIPMENT AND COSTS PER SITE CAPEX FOR ADDING PUBLIC SAFETY BROADBAND TO EXISTING SITES IN HIGHLY RURAL AREAS, INCLUDING HARDENING.

Rural Site Configuration A and B, for Asynchronous Build

Two different types of configurations are used for the underlying equipment for adding public safety broadband to highly rural areas. In addition, structure heights, or distances from the eNodeB to Antennas for the site locations, were evaluated at 225 feet. Microwave equipment and hardening are also included in the underlying cost analysis.

EQUIPMENT AND COSTS PER SITE CAPEX FOR PUBLIC SAFETY BROADBAND NEW SITES IN HIGHLY RURAL AREAS, INCLUDING HARDENING.

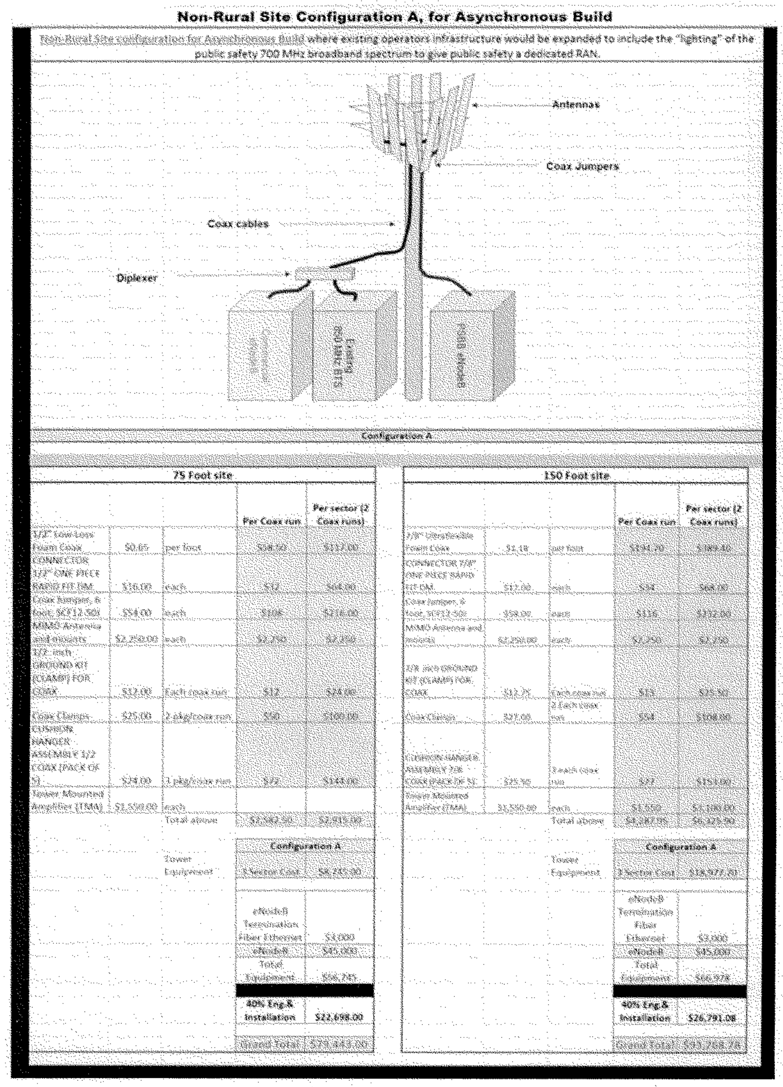
Two different types of configurations (A and B) are used for the underlying equipment for new sites in highly rural areas. In addition, structure heights, or distances from the eNodeB to antennas for the site locations, were evaluated at 225 feet. Microwave equipment and hardening was also included in the underlying cost analysis. New sites in highly rural areas also included Site Acquisition and Construction of up to a 225 foot structure/tower.

HARDENING

Hardening includes additional batteries and battery cabinet, structural analysis and improving the cell-site structure and antenna survivability designed for a wind loading, according to the Electronics Industry Association Structural Standards for Steel Antenna Tower and Antenna Supporting Structures (EIA/TIA-222). For rural sites, hardening also includes adding generators and associated equipment.[20]

MICROWAVE

Microwave equipment includes all equipment, path survey and installation for the microwave system. In addition, FCC applications, coordination and zoning are included in the cost structure.



Non-Rural Site Configuration A, for Asynchronous Build

Non-Rural Site configuration for Asynchronous Build where existing operators infrastructure would be expanded to include the "lighting" of the public safety 700 MHz broadband spectrum to give public safety a dedicated RAN.

Configuration A

75 Foot site

			Per Coax run	Per sector (2 Coax runs)
1/2" Low-Loss Foam Coax	$0.65	per foot	$58.50	$117.00
CONNECTOR 1/2" ONE PIECE RAPID FIT DM	$16.00	each	$32	$64.00
Coax Jumpers, 6 foot, SCF12-50J	$54.00	each	$108	$216.00
MIMO Antenna and mounts	$2,250.00	each	$2,250	$2,250
1/2 inch GROUND KIT (CLAMP) FOR COAX	$12.00	Each coax run	$12	$24.00
Coax Clamps	$25.00	2 pkg/coax run	$50	$100.00
CUSHION HANGER ASSEMBLY 1/2 COAX (PACK OF 5)	$24.00	3 pkg/coax run	$72	$144.00
Tower Mounted Amplifier (TMA)	$1,550.00	each		
		Total above	$2,582.50	$2,915.00

	Configuration A	
Tower Equipment	3 Sector Cost	$8,745.00
	eNodeB Termination Fiber Ethernet	$3,000
	eNodeB	$45,000
	Total Equipment	$56,745
	40% Eng.& Installation	**$22,698.00**
	Grand Total	$79,443.00

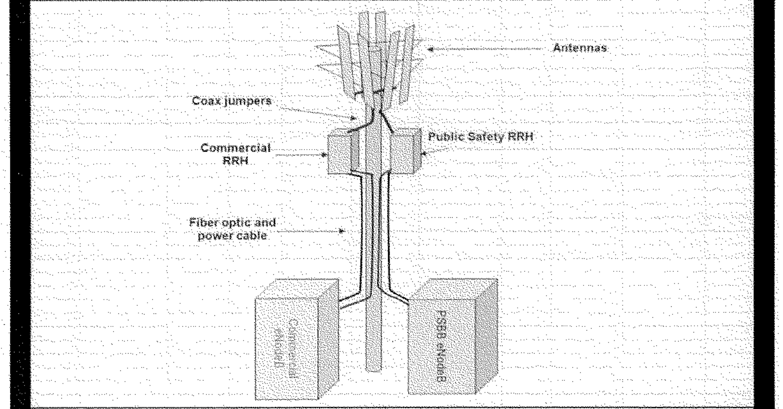
150 Foot site

			Per Coax run	Per sector (2 Coax runs)
7/8" Ultraflexible Foam Coax	$1.18	per foot	$194.70	$389.40
CONNECTOR 7/8" ONE PIECE RAPID FIT DM	$17.00	each	$34	$68.00
Coax Jumpers, 6 foot, SCF12-50J	$58.00	each	$116	$232.00
MIMO Antenna and mounts	$2,250.00	each	$2,250	$2,250
7/8 inch GROUND KIT (CLAMP) FOR COAX	$12.75	Each coax run	$13	$25.50
Coax Clamps	$27.00	2 Each coax run	$54	$108.00
CUSHION HANGER ASSEMBLY 7/8 COAX (PACK OF 5)	$25.50	3 each coax run	$77	$153.00
Tower Mounted Amplifier (TMA)	$1,550.00	each	$1,550	$3,100.00
		Total above	$4,287.95	$6,325.90

	Configuration A	
Tower Equipment	3 Sector Cost	$18,977.70
	eNodeB Termination Fiber Ethernet	$3,000
	eNodeB	$45,000
	Total Equipment	$66,978
	40% Eng.& Installation	**$26,791.08**
	Grand Total	$93,268.78

Non-Rural Site Configuration B, for Asynchronous Build

Non-Rural Site configuration for Asynchronous Build where existing operators infrastructure would be expanded to include the "lighting" of the public safety 700 MHz broadband spectrum to give public safety a dedicated RAN.

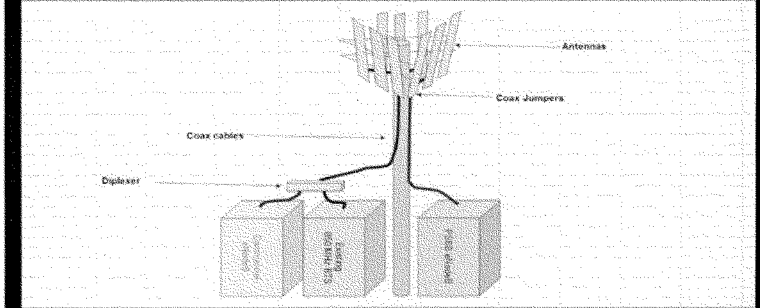


Configuration B

				75 Foot site		150 Foot site	
				Per Fiber run	Per sector (2 Fiber runs)	Per Fiber run	Per sector (2 Fiber runs)
Coax Jumper, 6 foot, SCF12-50J	$54.00	each		$108	$216.00	$116	$232.00
MIMO Antenna and mounts	$2,250.00	each		$2,250.00	$2,250	$2,250.00	$2,250
Remote Radio Head (RRH)	$4,875.00	each		$4,875	$4,875	$4,875	$4,875
Fiber Cable	$0.30	per foot		$27.00	$54	$49.50	$99
Power Cable	$0.05	per foot		$4.50	$9	$8.25	$17
Fiber Clamps	$11.00	2 pkg/run		$11.00	$22	$11.00	$22
Fiber connectors	$3.50	each		$7	$14	$7	$14
			Total above	$7,282.50	$7,440.00	$7,316.75	$7,508.50
				Configuration B		**Configuration B**	
			Tower Equipment	3 Sector Cost	$22,320.00	3 Sector Cost	$22,525.50
				eNodeB Termination Fiber Ethernet	$3,000	eNodeB Termination Fiber Ethernet	$3,000
				eNodeB	$45,000	eNodeB	$45,000
				Total Equipment	$70,320	Total Equipment	$70,526
				40% Eng.& Installation	**$28,128.00**	**40% Eng.& Installation**	**$28,210.20**
				Grand Total	$98,448.00	Grand Total	$98,735.70

Rural Site Configuration A, for Asynchronous Build

Rural Site configuration for Asynchronous Build where existing operators infrastructure would be expanded to include the “lighting” of the public safety 700 MHz broadband spectrum to give public safety a dedicated RAN.



Configuration A

225 Foot site				
			Per Coax run	Per sector (2 Coax runs)
1-1/4" Premium Attenuation Coax	$2.95	per foot	$708.00	$1,416.00
CONNECTOR 1-1/4" ONE PIECE RAPID FIT DM	$17.00	each	$122	$243.00
Coax Jumper, 6 foot, SCF12-50J	$58.00	each	$116	$232.00
MIMO Antenna and mounts	$2,350.00	each	$2,750	$2,750
1-1/4" GROUND KIT (CLAMP) FOR COAX	$12.25	Each coax run	$19	$37.00
Coax Clamps	$27.00	2 Each coax run	$140	$280.00
CUSHION HANGER ASSEMBLY 1-1/4" COAX (PACK OF 5)	$25.50	3 each coax run	$201	$402.00
Tower Mounted Amplifier (TMA)	$1,350.00	each	$1,350	$2,700.00
		Total above	$5,105.00	$7,960.00

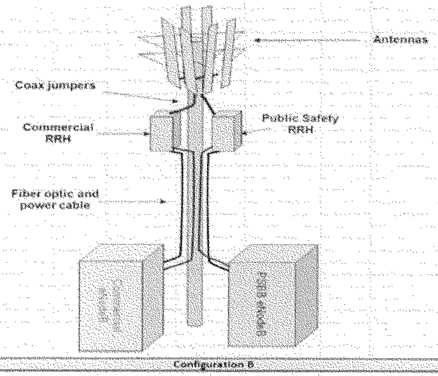
	Configuration A	
Tower Equipment	3 Sector Cost	$23,880.00
	eNodeB Termination Fiber-Ethernet	$3,000
	eNodeB	$45,000
	Total Equipment	$71,880
	[redacted]	[redacted]
	40% Eng.& Installation	$28,752.00
	Grand Total	$100,632.00

Total Rural Upgrade Site	Cost
Hardening	$70,000
Microwave equipment	$45,000
3 sector Equipment and Installation	$100,632.00
Total:	$215,632

Total New-Build Rural Site	Cost
Hardening	$70,000
Microwave equipment	$45,000
Site Acquisition, Zoning	$57,400
Construction	$90,000
3 sector Equipment and Installation	$100,632.00
Total:	$363,032

Rural Site Configuration B, for Asynchronous Build

Rural Site configuration for Asynchronous Build where existing operators infrastructure would be expanded to include the "lighting" of the public safety 700 MHz broadband spectrum to give public safety a dedicated RAN.

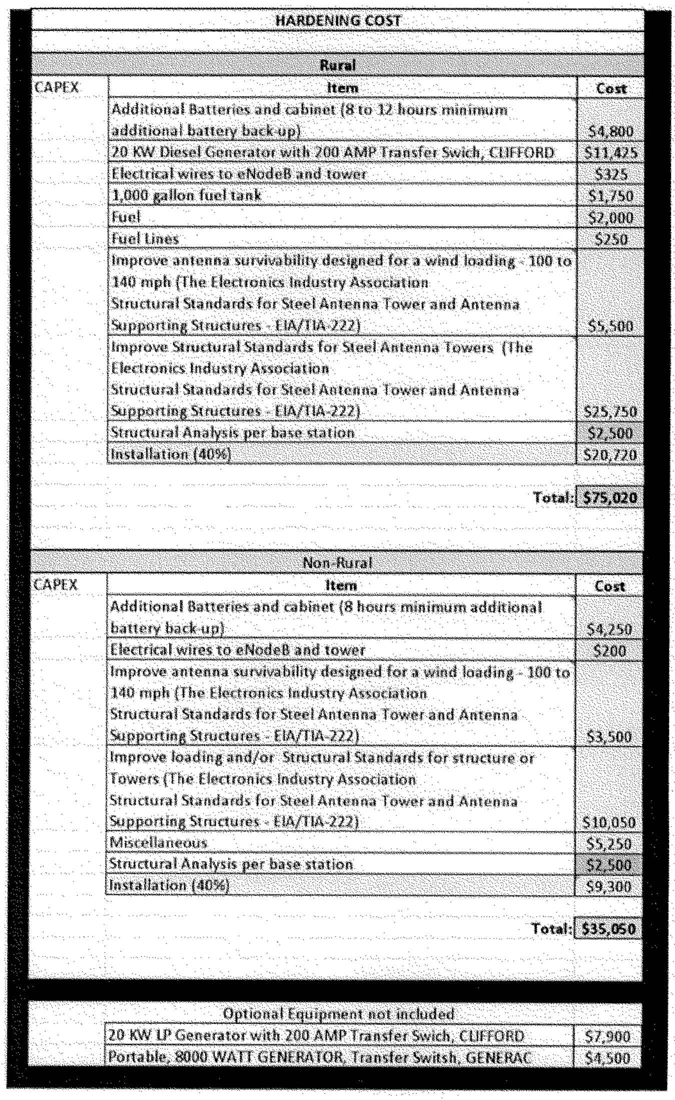


Configuration B

225 Foot site					
				Per Fiber run	Per sector (2 Fiber runs)
Coax Jumper, 6 foot, SCF12-50J	$54.00	each		$116	$232.00
MIMO Antenna and mounts	$2,250.00	each		$2,250.00	$2,250
Remote Radio Head (RRH)	$4,875.00	each		$4,875	$4,875
Fiber Cable	$0.30	per foot		$72.00	$144
Power Cable	$0.05	per foot		$12.00	$24
Fiber Clamps	$11.00	2 pkg/run		$11.00	$22
Fiber connectors	$3.50	each		$7	$14
			Total above	$7,343.00	$7,561.00
				Configuration B	
			Tower Equipment	3 Sector Cost	$22,683.00
				eNodeB Termination Fiber Ethernet	$3,000
				eNodeB	$45,000
				Total Equipment	$70,683
				[redacted]	
				40% Eng.& Installation	$28,273.20
				Grand Total	$98,956.20

Total Rural Upgrade Site	Cost
Hardening	$70,000
Microwave equipment	$45,000
Equipment and	$98,956.20
Total	$213,956

Total New-Build Rural Site	Cost
Hardening	$70,000
Microwave equipment	$45,000
Site Acquisition, Zoning	$57,400
Construction	$90,000
3 sector Equipment and Installation	$98,956.20
Total	$361,356



HARDENING COST

Rural

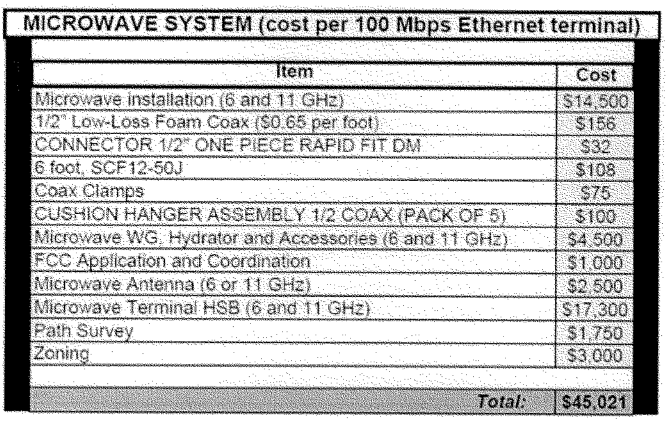
CAPEX	Item	Cost
	Additional Batteries and cabinet (8 to 12 hours minimum additional battery back-up)	$4,800
	20 KW Diesel Generator with 200 AMP Transfer Swich, CLIFFORD	$11,425
	Electrical wires to eNodeB and tower	$325
	1,000 gallon fuel tank	$1,750
	Fuel	$2,000
	Fuel Lines	$250
	Improve antenna survivability designed for a wind loading - 100 to 140 mph (The Electronics Industry Association Structural Standards for Steel Antenna Tower and Antenna Supporting Structures - EIA/TIA-222)	$5,500
	Improve Structural Standards for Steel Antenna Towers (The Electronics Industry Association Structural Standards for Steel Antenna Tower and Antenna Supporting Structures - EIA/TIA-222)	$25,750
	Structural Analysis per base station	$2,500
	Installation (40%)	$20,720
	Total:	**$75,020**

Non-Rural

CAPEX	Item	Cost
	Additional Batteries and cabinet (8 hours minimum additional battery back-up)	$4,250
	Electrical wires to eNodeB and tower	$200
	Improve antenna survivability designed for a wind loading - 100 to 140 mph (The Electronics Industry Association Structural Standards for Steel Antenna Tower and Antenna Supporting Structures - EIA/TIA-222)	$3,500
	Improve loading and/or Structural Standards for structure or Towers (The Electronics Industry Association Structural Standards for Steel Antenna Tower and Antenna Supporting Structures - EIA/TIA-222)	$10,050
	Miscellaneous	$5,250
	Structural Analysis per base station	$2,500
	Installation (40%)	$9,300
	Total:	**$35,050**

Optional Equipment not included

	20 KW LP Generator with 200 AMP Transfer Swich, CLIFFORD	$7,900
	Portable, 8000 WATT GENERATOR, Transfer Switsh, GENERAC	$4,500



MICROWAVE SYSTEM (cost per 100 Mbps Ethernet terminal)

Item	Cost
Microwave installation (6 and 11 GHz)	$14,500
1/2" Low-Loss Foam Coax ($0.65 per foot)	$156
CONNECTOR 1/2" ONE PIECE RAPID FIT DM	$32
6 foot, SCF12-50J	$108
Coax Clamps	$75
CUSHION HANGER ASSEMBLY 1/2 COAX (PACK OF 5)	$100
Microwave WG, Hydrator and Accessories (6 and 11 GHz)	$4,500
FCC Application and Coordination	$1,000
Microwave Antenna (6 or 11 GHz)	$2,500
Microwave Terminal HSB (6 and 11 GHz)	$17,300
Path Survey	$1,750
Zoning	$3,000
Total:	**$45,021**

REFERENCE

Tessco, http://www.tessco.com/ (last visited March, 6 2010).

Meridian Microwave, http://www.meridianmicrowave.com/#0%20-%206%20miles (last visited March, 6 2010).

Radio Frequency Systems, http://www.lwsonline.de/oxid/ (last visited March, 6 2010).

Huawei, http://www.huawei.com/site_products.do (last visited March, 6 2010).

Powerwave, http://www.powerwave.com/datasheets.asp (last visited March, 6 2010).

Clifford Power Systems, Inc., http://www.cliffordpower.com/ (last visited March, 6 2010).

Fred A. Nudd Corporation, http://www.nuddtowers.com/ (last visited March, 6 2010).

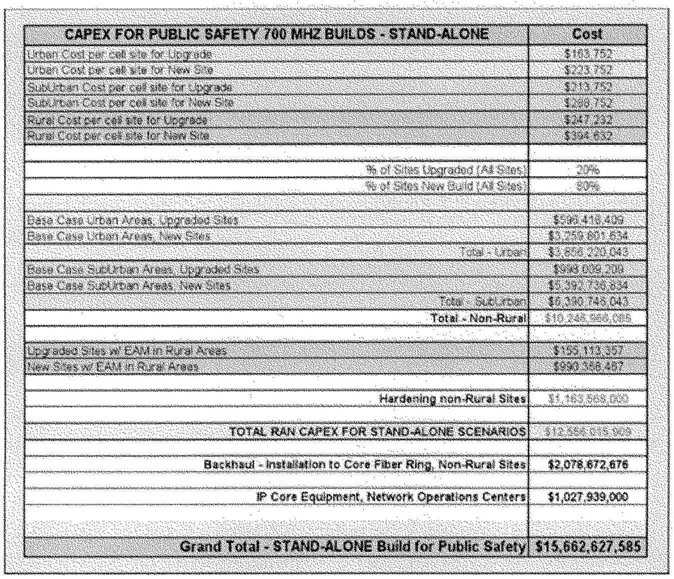
Telecommunications Industry Association, http://www.tiaonline.org/ (last visited March, 6 2010).

Commscope, "Wind Loading on Basic Antennas," http://www.commscope.com/andrew/eng/support_document/tech_info/antennas/__icsFiles/afieldfile/2009/07/13/wind_loading_on_base_stationantennas_white_Paper.pdf

Valere Power Systems, http://www.eltekvalere.com/wip4/ (last visited March, 6 2010).

http://www.generac.com/Full_Product_Line/ , (last visited March, 6 2010).

APPENDIX D: CAPEX FOR PUBLIC SAFETY 700 MHZ BUILDS—STAND-ALONE



CAPEX FOR PUBLIC SAFETY 700 MHZ BUILDS - STAND-ALONE	Cost
Urban Cost per cell site for Upgrade	$163,752
Urban Cost per cell site for New Site	$223,752
SubUrban Cost per cell site for Upgrade	$213,752
SubUrban Cost per cell site for New Site	$288,752
Rural Cost per cell site for Upgrade	$247,232
Rural Cost per cell site for New Site	$394,632
% of Sites Upgraded (All Sites)	20%
% of Sites New Build (All Sites)	80%
Base Case Urban Areas, Upgraded Sites	$596,418,409
Base Case Urban Areas, New Sites	$3,259,801,634
Total - Urban	$3,856,220,043
Base Case SubUrban Areas, Upgraded Sites	$998,009,209
Base Case SubUrban Areas, New Sites	$5,392,736,834
Total - SubUrban	$6,390,746,043
Total - Non-Rural	$10,246,966,085
Upgraded Sites w/ EAM in Rural Areas	$155,113,357
New Sites w/ EAM in Rural Areas	$990,368,467
Hardening non-Rural Sites	$1,163,568,000
TOTAL RAN CAPEX FOR STAND-ALONE SCENARIOS	$12,556,015,909
Backhaul - Installation to Core Fiber Ring, Non-Rural Sites	**$2,078,672,676**
IP Core Equipment, Network Operations Centers	**$1,027,939,000**
Grand Total - STAND-ALONE Build for Public Safety	**$15,662,627,585**

ACKNOWLEDGEMENTS

The Omnibus Broadband Initiative acknowledges the efforts of Stagg Newman, Brian Hurley, Jon Peha, Pat Amodio, Ziad Sleem, Behzad Ghaffari, Jeffery Goldthorp, John Leibovitz, Tom Peters, Walter Johnston, Mike Iandolo, Jerome Stanshine, Yoon Chang, Kurian Jacob and Jennifer A. Manner in preparing this paper.

ENDNOTES

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[1] For an extensive discussion of how the public safety broadband network will use deployable equipment, see Appendix A.

[2] A detailed discussion of the assumptions underlying the network cost model is provided in Appendix B.

[3] Because network designs and assumptions may change over time, it is imperative that the funding agency ensures that there is an annual review of the funding available for each program.

[4] Through partnering, RFP respondents will see an effective reduction in capex associated with their own network build out as well as an improvement in reliability through side hardening for public safety.

[5] *See* http://www22.verizon.com/Content/ExecutiveCenter/Richard_Lynch/mobile_world_congress/mobile_world_congress.htm (last visited Feb. 20, 2010); *see also* http://www.att.com/gen/press-room?cdvn=news&newsarticleid=30493&pid=4800 (last visited Feb. 20, 2010).

[6] The model excludes the costs of EMAs, which are components of subscriber devices used for vehicular coverage. EMAs are standard equipment used in public safety vehicles to improve coverage.

[7] We assumed $35,000 per site for hardening in non-rural areas, and $70,000 per site in highly rural areas.

[8] Portable user equipment or radios with ancillary support equipment stored and available for emergency use

[9] We have not included any costs that might be incurred for roaming by the public safety operator on a commercial network. Public safety will be able to obtain roaming services at favorable commercial rates.

[10] This assumes a cost range from $100,000 to $400,000 for next generation deployable cell sites as well as a cost of up to $10,000 per vehicle for vehicular area network systems.

[11] Appendix C provides more detail on the cost model used to calculate overall capital expenses for the network. Actual costs for a particular region for a specific RFP will vary on a line-by-line basis.

[12] The proposed funding covers network operations. The funding is not intended to cover the operations of the services and applications running on top of that network nor various administrative functions associated with public safety network operations that agencies may incur. These costs which are part of day-to-day operations today which we have assumed will continue to be borne by the local agencies.

[13] Public safety regions could deploy networks with fewer cell sites, but such networks would provide worse performance, slower speeds, and less total capacity. For the case of the Stand-Alone build we used 20% existing public safety sites and 80% new sites, based on the number of LMR sites that typically serve a region compared with the number of cellular sites.

[14] Based on Sprint Nextel and Verizon Wireless annual reports for 2009, OpEx is approximately twice CapEx. Based on our analysis, the range of ongoing costs is 1.5 to 2.5 times the total CapEx amount, with two times the total CapEx amount as the norm. For some Stand-Alone networks, Ongoing Costs could be higher. For these reasons, we have estimated costs based on a range.

[15] Ongoing Costs equal to 1.5 times the total CapEx amount is the lower bound. Appendix D provides a more detailed cost breakdown of the CapEx for the $15.7 B

[16] *See* SGA Task Force: Achieving Interoperability for Public Safety Communications (2007): Response of Verizon Communications and Verizon Wireless (Mar. 16, 2007).

[17] *See* Henry Morgenstern, *NYCWiN Interoperable Communications: A Report on the New York City Wireless Network*, Counter Terrorist Magazine, Sept./Oct. 2008, available at http://www.thecounterterroristmag.com/pdf/Issue3.NYCWIN.Morgenstern.Lo.pdf (last accessed Mar. 26, 2010). *See also* Department of Information Technology and Telecommunications, Testimony before the City Council Committees on Fire and Criminal Justice Services, Public Safety, and Technology in Government Oversight - Implementation Status of the New York City Wireless Network (Feb. 25, 2008).

[18] See supra 14

[19] Letter from Brian Ponte, Vice President for Business Development, LEMKO Corporation, to Marlene H. Dortch, Secretary, FCC (Mar. 12, 2010).

[20] Many commercial sites today have battery back-up and structural hardening and back-up power systems for primary sites but not for secondary sites. The model assumed hardening and batteries for all sites with diesel generators as optional. In practice, the funds not needed for sites that are already hardened could be used for diesel generators at other sites. The localization of the RFP approach allows solutions to be tailored to the local needs and environment.

Congress of the United States
Washington, DC 20515

July 13, 2011

The Honorable John Boehner
House Speaker
U.S House of Representatives
H-232, The Capitol
Washington, DC 20515

The Honorable Nancy Pelosi
House Democratic Leader
U.S. House of Representatives
H-204, The Capitol
Washington, DC 20515

Dear Speaker Boehner and Leader Pelosi:

As part of an agreement to raise the federal debt ceiling, we understand that Congress may include language to grant authority to the Federal Communications Commission (FCC) to conduct voluntary incentive auctions for the purpose of inducing some television broadcasters to turn in their current licenses. We would urge you to ensure that federal legislation and spectrum policies authorizing incentive auctions are structured so that broadcasters' decisions are truly voluntary, and so that broadcasters who wish to continue to serve the public may do so. As importantly, we also urge you to ensure that legislation and policies do not work to deny viewers over-the-air access to diverse programming and emerging services, such as digital multicast, high definition, and mobile DTV.

We would urge you to ensure that (1) viewers do not lose access to their current roster of television stations because of increased interference or reduced coverage areas, (2) television stations are not involuntarily relocated in a manner that would preclude them from offering innovative new services, and (3) television stations are reimbursed for costs associated with relocating to new channels.

We want to make sure that voluntary incentive auctions do not threaten diversity of programming. It concerns us that many television stations, particularly those independently owned and operated broadcast television networks aimed at minority audiences, could be imperiled if broadcasters are "repacked" onto new channels without sufficient safeguards.

For instance, new niche minority-oriented networks are beginning to avail themselves of multicasting opportunities due to the digital television transition. Bounce TV, which is owned by a group of African American investors, including Andrew Young and Martin Luther King III, is a new over-the-air television network aimed at African American audiences. Bounce TV is planning its launch this fall with a mix of movies, live sports and original programming over the digital multicast signals of local television stations. Initially, Bounce TV programming will air on approximately 60 broadcast station outlets covering 35 percent of the country, giving underserved African American consumers a new, free local television brand designed specifically for them.

Broadcast television is relied upon by 99 percent of the American population. In fact, some 46 million Americans depend exclusively on free over-the-air broadcasting as their only source of television. Many of those viewers are impoverished, elderly, live in rural areas, or are members of an ethnic minority. As you are considering legislation to grant the FCC the authority to conduct voluntary incentive auctions, we ask that you consider the aforementioned safeguards and our concerns.

Respectfully,

Bobby L. Rush
Member of Congress

Edolphus "Ed" Towns
Member of Congress

G. K. Butterfield
Member of Congress

Donna M. Christensen
Member of Congress

August 9, 2011

Mr. Christopher M. Moore
Chief of Police
San Jose Police Department
201 West Mission Street
San Jose, CA 95110

Dear Chief Moore,

Thank you for appearing before the Subcommittee on Communications and Technology on Friday, July 15, 2011, to testify at the hearing entitled "Legislative Hearing to Address Spectrum and Public Safety Issues."

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for 10 business days to permit Members to submit additional questions to witnesses, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and then (3) your answer to that question in plain text.

To facilitate the printing of the hearing record, please respond to these questions by the close of business on Tuesday, August 23, 2011. Your responses should be e-mailed to the Legislative Clerk, in Word or PDF format, at Kirby.Howard@mail.house.gov.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,

Gregg Walden
Chairman
Subcommittee on Communications and Technology

cc: Anna G. Eshoo, Ranking Member, Subcommittee on Communications and Technology

Attachment

Subcommittee on Communications and Technology
Legislative Hearing to Address Spectrum and Public Safety Issues
July 15, 2011
Additional Questions for the Record

The Honorable Anna G. Eshoo

1. Why is competition in the public safety device market so important and how would it benefit a department like yours?

   Competition in the public safety market is critical to driving down prices for communications services and equipment, at the device level, as well as with respect to applications and infrastructure. Unfortunately, public safety has become a niche market in which proprietary technology has resulted from limited competition and unique requirements that are higher than the larger commercial and non-mission-critical markets. This has caused higher equipment prices for public safety in comparison to the larger commercial market. As public safety begins to deploy Broadband and adopted LTE technologies, the goal is to use open source and standards-based commercial devices and applications that will increase the economies of scale, thereby driving down the cost of equipment, while saving state, local and regional jurisdictions millions of dollars in expenses associated with device purchases. Even the adoption of LTE helps to establish a standard and generate economies of scale. Indeed, in April 2011 the Global Alliance formally adopted LTE as the worldwide standard for public safety broadband following its adoption in the United States.

   This is very important for all public safety agencies, which are facing very tough budget issues over the next several years, especially departments like mine where we have found it necessary to layoff hundreds of officers and eliminate positions because of the current economic hardship. We're being continually asked to do more with less. If we can find a reliable way to decrease the cost of equipment, applications and infrastructure, including devices, then the money saved might be able to place more officers back on the street to continue to prevent crime and protect the public.

2. What are some of the advantages for the American taxpayer of encouraging the private sector to partner with public safety for the deployment and utilization of a national public safety broadband network? Will such partnerships reduce costs of deployment to the taxpayer?

   While such partnerships would reduce costs of deployment to the taxpayer, the ability of public safety to strategically engage in public-private partnerships will be nonexistent unless the D Block is allocated to public safety. A 10 MHz (5x5) network simply lacks a pipe large enough for public safety to share such a small amount of spectrum. In fact, it has been demonstrated that a simple 5x5 LTE network would in most instances not provide enough bandwidth for even regular, day-to-day public safety use. Specifically, work done and recently presented to Congress by wireless experts Andrew Seybold and Pete Rysavy clearly illustrates that 10 MHz is not enough nor is building out on only 10 MHz now economically efficient for public safety to do in the immediate-to-long-term.

   If the D Block were to be allocated to public safety, the resulting 20 MHz (10x10) network would better lend itself to establishing strategic public-private partnerships with a number of entities, including rural communications providers in an effort to bring broadband to sparsely populated communities. These partnerships could attract new partners and increase competition in the marketplace as well. Additionally, strategic partnerships with utilities, smart grid and critical infrastructure providers present an ideal natural partnership with the proposed public safety broadband network. These industries already build out networks to a mission critical-grade

standard, and the resulting ability to share infrastructure would greatly reduce the capital expenditures and operating expenses associated with the network.

The public-private partnerships are an essential part of building out the nationwide interoperable public safety broadband network. Only the Public Safety Broadband Plan allows for that option. The goal is to create a sustainable governance model that can drive down the cost of building out and maintaining the network, providing sufficient funding to sustain it for the long-term, and allowing the network to evolve leveraging new commercial technologies soon after they come into consumer communications devices, but with public safety grade and mission-critical capabilities. We are confident that strategic public-private partnerships will ultimately help us achieve this goal, but only if the D Block is allocated to public safety.

The Honorable Charles F. Bass

1. In addition to the committee's work here in Washington, I have been engaged with the New Hampshire public safety community and have heard from a wide variety of officials on their communications needs. In addition to the need for an interoperable broadband network, law enforcement and other emergency personnel in northern New Hampshire have brought another issue to my attention: the coordination of radio licensing in border areas. Because of diplomatic agreements between the U.S. and Canada governing the licensing approval process, there has been an unintended consequence of limiting access to radio channels and frequencies.

   Are there ways that Congress could improve the coordination process with our neighboring countries? Is this a problem that is unique to New Hampshire?

   No, this is not a problem unique to New Hampshire. All states that share the border with Canada and Mexico have this problem, and it extends to broadband as well. The Federal Communications Commission (FCC) and the U.S. State Department have been very helpful in negotiating with their counterparts in Mexico and Canada, and we believe that there is a good chance some of these issues will be resolved shortly. Congress can help this effort by providing additional support to the FCC and the State Department to get these issues resolved as quickly as possible. There is some concern that, without allocation of the D Block, the current 10 MHz public safety broadband capability already being used by "waiver" jurisdictions may not be sufficient particularly in border areas because of the need for "guard bands" to protect from potential interference with our international neighbors.

   Furthermore on the international front, countries in Europe, Asia, the Middle East, South America, Australia and New Zealand have begun to follow the U.S. lead to create a 20 MHz LTE broadband network in the 700 MHz band for public safety. An international and potentially global market for public safety broadband LTE equipment, applications and network infrastructure would increase competition and reduce the cost to public safety by increasing the number of users and devices that would be manufactured. The adoption of the LTE standard and deployment of similar broadband networks would also improve coordination and cooperation between Canadian and Mexican law enforcement officials to protect our Nation's border security. As well, by allowing for "secondary" users on the public safety spectrum, we further expand the amount of users, sharing and partnering opportunities, standards adoption, and ultimately attract more competition and lower prices for all.

2. What are some of the advantages for the American taxpayer of encouraging the private sector to partner with public safety for the deployment and utilization of a national public safety broadband network? How can such partnerships reduce costs of deployment to the taxpayer?

Please see the answer to question number two as submitted by the Honorable Anna Eshoo.

The Honorable Henry Waxman

1. During the hearing, Chairman Walden asked Mr. Guttman-McCabe to describe what worked and what did not with respect to the public safety and commercial wireless networks during the 9/11 attacks and Hurricane Katrina. How would you assess the impact on both networks, and how do these experiences translate into efforts to create a public safety broadband network that can best help first responders protect the safety of life and property, particularly in the event of a next disaster?

All communications systems - public, private and commercial - had severe problems both during the 9/11 attacks and Hurricane Katrina. These problems have been well documented in the FCC's Katrina report and other reports that have been filed since then. Public safety agencies have been working hard to improve the operability and interoperability of their systems since these disasters.

In light of yesterday's earthquake that struck northern Virginia, we hope the Chairman would consider asking this question again to Mr. Guttman-McCabe. It should be noted that while Mr. Guttman-McCabe noted how many calls were processed, he neglected to mention how many calls were dropped and delayed.

The magnitude 5.9 earthquake in northern Virginia once again underscored the critical need for allocating the D Block spectrum and funding to public safety to build a nationwide interoperable broadband network. This moderate earthquake, which was felt from North Carolina to Toronto and beyond, demonstrates why first responders need a nationwide interoperable network. A more severe earthquake could have resulted in devastating loss of life and property in the heart of our Nation's Capital.

What was immediately apparent to the hundreds of thousands of people who flooded the streets after the quake was that their cell phones and wireless data networks did not work because of severe congestion. Commercial wireless networks quickly became overloaded and people were not able to call, text or email their friends and family.

While there were no reports of outages or congestion on public safety radio systems, there was an impact on first responders and emergency personnel who relied on their commercial cell phones and data cards to communicate with their colleagues. Numerous first responders were stymied and forced to wait to communicate during yesterday's emergency efforts. Hundreds of thousands of mobile phone consumers trying to contact loved ones could not get through due to overcrowded wireless networks.

Clearly, public safety cannot rely on commercial networks during critical incidents and major events, as they would not be able to gain the level of priority access necessary to be effective in such incidents, nor can they even gain access to the system to establish their priority access. Such a predicament is not new for public safety. Last year, the New York City Police Department (NYPD), New York City Fire Department (NYFD) and the New York City Information Technology Department submitted a joint filing to the Federal Communications Commission (FCC) which listed more than a dozen occasions since 9/11 where commercial networks overloaded and/or failed, resulting in a delays and the loss of cell phone service for citizens and first responders alike.

The events yesterday once again prove how powerful the argument for dedicated spectrum is for public safety, and demonstrate why Public Safety organizations and state and local officials throughout the United States have repeatedly asked Congress to enact legislation, such as S.911, that would provide for the creation and funding of a nationwide, interoperable communications network before the 10th anniversary of the 9/11 terrorist attacks – which is weeks away.

I ask that Congress give top priority to passing S. 911, The Public Safety Spectrum and Wireless Innovation Act of 2011 now, and that this committee introduce and vote on legislation on this matter with all due haste.

2. Each of the staff drafts provide for a national governance model, but differ substantially in approach. Why do you favor the approach to governance in the Waxman-Eshoo discussion draft?

   We strongly believe that the approach to the governance in the Waxman-Eshoo discussion draft provides the best combination of structure and governance to ensure the proper build out of the public safety broadband network and that the operations of the network are properly managed for years to come. The National Governors Association recently put out a memo to the House Energy and Commerce Committee that articulates many of the reasons why we support the Waxman-Eshoo Draft, which closely aligns with the bipartisan legislation that the Senate Commerce Committee recently passed out of committee on a 21-4 vote, S.911. Overall, while the federal government is a key partner to this nationwide network, we do not believe that the Walden Discussion Draft removes the governing entity far enough from federal control by maintaining it within the federal government structure. We believe that the entity should have more independence from federal control, while still providing sufficient federal involvement, as there are multiple public safety and first responder agencies within the federal government employing tens of thousands of public safety and first responder personnel that need to be part of the network, and interoperable with the network. We also believe it is important not to put the entity under a single federal agency or department. Indeed, we would like to see a majority of the Board Members on the governing body, the Public Safety Broadband Corporation, be qualified state and local public safety professionals as our first preference, or at least a majority be a combination of state and local public safety professionals and state and local government officials as our secondary preference, which is fully shared by the Big 7 organizations collectively representing the nation's state and local governments.

3. The staff drafts also differ on how the public safety broadband spectrum is to be licensed. The Republican staff draft would assign each state a license for the public safety broadband spectrum, and section 201(c) would have each state contract for the construction and operation of a public safety broadband network, resulting in 50 separate networks. The Democratic staff draft would grant a single license to the Public Safety Broadband Corporation, which would be responsible for ensuring nationwide uniformity and interoperability, among other responsibilities. What problems do you believe would occur with a state-by-state licensing and network build approach?

   We strongly support the issuance of a single, national license to the Public Safety Broadband Licensee, as designated as the Public Safety Broadband Corporation in S.911 and the Waxman-Eshoo Discussion Draft with the ability for the PSBL to issue sublicenses to states, regions and localities while ensuring that each sublicense complies with established standards and other requirements to assure successful implementation and nationwide interoperability. We would oppose legislation assigning licenses to each state. The idea that each state would build out a

separate network overlooks the obvious problems that have plagued public safety communications for almost a century: a lack of interoperability. What safeguards are in place to ensure that each state develops a coordinated network that is fully interoperable not just with neighbors, but with the entire United States? These potentially proprietary networks would ultimately increase the cost of initial build out, and would also increase the cost of the maintenance of the nationwide network of networks. We also envision a problem in the overall completion of the network. If left to the states individually, some may view the build out as a top priority whereas other states may not. A nationwide plan would ensure a nationwide build out; a state plan would virtually ensure a piecemeal implementation of expensive and non-interconnected proprietary network builds. The result would be 50 free standing "islands" of networks, instead of a single contiguous and interoperable public safety broadband network.

4. How important is it to ensure that devices capable of operating in the public safety broadband spectrum are available and at reasonable cost? Do you support Sections 105(a)(4) and 203(e)(2)(E) of the Democratic staff draft, which seek to ensure the availability of Band Class 14 devices for public safety at reasonable prices?

   This is vital to having a viable network that would be able to evolve as commercial technologies evolve. Today's public safety device "market" is but niche market, the resulting effects of which have made new entry cost prohibitive. Naturally, the cost of devices for the public safety community are incredibly high thanks to the "specialized" nature of their market.

   We recognize the fact that having devices that can operate on the public safety spectrum and on the commercial spectrum would not only reduce device cost but also allow for roaming across networks during incidents as needed.

   While having devices that operate across the entire 700 MHz band might still be years in the future, we believe that commercial carriers, which operate in the 700 MHz band, can and should offer devices that operate on their networks, as well as on band class 14. Indeed, in our conversations with them, they have committed to as much.

5. In your oral testimony, you stated that if planned deployments of 700 MHz narrowband systems do not occur, the American public would be less safe. The Democratic and Republican drafts have different approaches to transferring 700 MHz narrowband to broadband use. Which approach do you prefer and why?

   We prefer the Democratic draft.

   The reason we oppose the Republican draft language is because thirty-three States and nearly 200 local jurisdictions have active or pending licenses to use the 700 narrowband spectrum for mission-critical land mobile radio communications. There are 10,854 active licenses, 2,179 pending licenses, and 1,036 new licenses. This spectrum is also used to support statewide operations that have cost State governments tens of millions of dollars to build out.

   The Federal government has provided, and State and local governments have spent billions of dollars building out 700 MHz narrowband systems. Additional deployments are pending, and new construction projects are currently underway. The procurement of equipment for the 700 MHz LMR systems is based on operational life span of 15 to 20 years.

The Republican draft language in the legislation does not provide funding to offset the costs that have been incurred by State and local governments, nor does it provide funding to offset the pending costs for new deployments. Even more troubling, the Republican draft language does not offer a migration path to other suitable spectrum, as LTE will not provide mission critical voice communications for several years to come.

Cost of Previous Rebanding Effort: **In 2004, the FCC issued an Order that required public safety agencies to reband their use of 800 MHz spectrum. The purpose of the Order was to eliminate dangerous interference that was caused by Sprint/Nextel's cellular operations in the adjacent spectrum bands. In 2004, the FCC estimated that it would take 3 years to complete the rebanding effort. The FCC also required Sprint/Nextel to get a $5 billion bond to pay for it. Today, it is been reported that more than $3 billions has been spent on this effort, and nearly 8 years after the Order was issued, there are still thousands of public safety agencies that need to reband their 800 MHz systems, especially in border areas.**

Cost of Rebanding 700 MHz: **There is no official cost estimate to reband the 700 MHz band; however, the cost of the proposal will most likely be no less than the cost of the 800 MHz rebanding effort, which is still estimated to be nearly $5 billion by the time the process is finished. This cost would be in addition to the $10-12 billion that it will cost to build out a nationwide broadband network.**

Problems with Rebanding 700 MHz Narrowband Spectrum: **Unlike the 800 MHz rebanding process, there is no similar spectrum to move the current 700 MHz narrowband licensees. Without sufficient spectrum to move the active and pending 700 MHz narrowband licensees, public safety will not be able to relocate their current 700 MHz LMR equipment.**
If public safety agencies are forced to operate on a different spectrum band, they will need to purchase completely new equipment. Lack sufficient spectrum in other spectrum bands will also result in diminished use and potentially dangerous congestion and inference with other public safety systems.

As noted before, LTE broadband technologies do not provide voice at all, let alone mission-critical push-to-talk and talk-around voice, and the commercial providers equipment manufacturers have indicated it may take up to 5-10 years before broadband can provide mission-critical voice capabilities. It is premature to rely solely on broadband technologies to replace mission-critical voice communications.

If there is no Federal funding for the 700 MHz rebanding effort that is being proposed in the Republican draft language, then this provision in the bill amounts to an unfunded mandate on State and local governments that many are unable to shoulder during these incredibly difficult economic times.

Subcommittee on Communications and Technology
Legislative Hearing to Address Spectrum and Public Safety Issues: Responses to Additional Questions for the Record

Prepared Testimony of Peter Cramton[1]
Professor of Economics, University of Maryland
Chairman, Market Design Inc.

Before the United States House Committee on Energy and Commerce
15 August 2011

Mr. Chairman and members of the House Committee on Energy and Commerce:

My responses to the additional questions for the record follow.

The Honorable Henry Waxman

1. Mr. Calabrese stated in his testimony that the auction model proposed in Section 104 of the Republican discussion draft would likely inject uncertainty into the auction process and undoubtedly lower the score that CBO would put on what would be an unpredictably contingent auction. Do you agree?

Yes. Section 104 of the Republican discussion draft is extremely problematic. Although the auctioning of licensed spectrum is essential to identifying the best *private* use of the spectrum, it does not follow that unlicensed spectrum should be auctioned in competition with those seeking licensed spectrum. The economics of unlicensed and licensed spectrum are radically different. Unlicensed spectrum is for *shared* use by all. No party is excluded from its use. In contrast, licensed spectrum is reserved for the sole use of the licensee. Bidders for licensed spectrum are motivated to bid, since if they win they are granted exclusive use of the licensed spectrum. Bidders for unlicensed spectrum have little incentive to bid, since the rights of winners are the same as the rights of losers.

The bidders for unlicensed spectrum would face a huge free-rider problem that the bidders for licensed spectrum do not face. If bidders for unlicensed spectrum had to compete with bidders for licensed spectrum, as Section 104 requires, the licensed use would invariably win, even in circumstances where unlicensed use creates dramatically more social value.

The analogy with private (licensed) and public (unlicensed) land fits perfectly. Consider Yellowstone National Park. Suppose rather than setting aside Yellowstone for public use, it were auctioned and the winner would determine whether it would be for public use or private use. Those bidding for private use would invariably win, even though the social value from public use is much greater.

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[1] My specialty is the design of complex auction markets. Since 1993, I have contributed extensively to the development of spectrum auctions. I have advised ten governments on spectrum auctions, including the United States. I am currently advising the United Kingdom, Canada, and Singapore. I have advised 35 bidders in major spectrum auctions around the world. I have written dozens of practical papers on spectrum auctions. This research is available at www.cramton.umd.edu/papers/spectrum.

The decision to set aside some spectrum for unlicensed use must necessary be a regulatory decision, weighing the benefits of public and private use. Auctions cannot make this determination.

Unlicensed spectrum plays an essential role in fostering innovation and competition in communications. Section 104 would effectively eliminate additional unlicensed spectrum and thereby undermine this important mechanism for innovation and competition.

2. Mr. Calabrese stated in his testimony that spectrum speculators, not non-carrier firms, have the most incentive to purchase unlicensed bands especially for those bands of little interest to carriers. Do you agree?

Yes, because of the free-rider problem for those seeking the unlicensed use, the highest bids would invariably come from those seeking a private use of the spectrum, even if the spectrum is not of immediate interest to carriers. As a result, spectrum with a high social value in the unlicensed use would remain in private hands. This would undermine innovation and competition in communications.

3. Mr. Guttman-McCabe stated in his oral testimony that the open access conditions applied to the 700 MHz C Block led to lessened bidder interest and significantly reduced the amount of revenue received when compared with the adjacent A and B Blocks. Do you agree?

No. I have studied the 700 MHz auction extensively. Shortly before the due date of bidder applications, both AT&T and Verizon endorsed the open access provisions. It is extremely unlikely that the open access provisions played a role in the price difference. What costly steps has Verizon taken on the C block to conform to open access provisions that AT&T has not done on the B block? I doubt one can find any.

Prices differences are much better explained by the level of competition for the various blocks. In the 700 MHz auction, the C block had the least competition because of the large license size, which made it difficult for regional operators to compete on the C block. This left just AT&T and Verizon to compete on the C block, but AT&T decided early that it was better to avoid competition with Verizon and focus on the B block instead. Once AT&T made this decision it was difficult or impossible to reverse course given the auction rules.

It is now well-understood that large price differences are possible across blocks in a simultaneous multiple round auction when blocks are offered with different geographic partitions. See my paper, "Spectrum Auction Design" for details.

4. Commissioner McDowell of the FCC recently stated that that a carve-out for unlicensed white spaces spectrum would "add[] a positive and constructive chaos to the marketplace." Do you agree with the Commissioner's statement that unlicensed spectrum, and white spaces in particular, promotes competition?

Yes. As I mentioned above, unlicensed spectrum plays a vital role in fostering innovation and competition in communications. Unlicensed use allows alternative business plans that are distinctly different from those of licensed operators. The experience with Wi-Fi is a good case in point. Wi-Fi has enabled a variety of communications and greatly expanded the power of major wireless devices. We certainly need a mix of unlicensed and licensed use to achieve the greatest social value. Setting aside some TV white spaces for unlicensed use will add an important opportunity for innovation and competition in communications.

The Wi-Fi spectrum does not have serious congestion problems because it is low power. The efficient allocation of spectrum should have some high-speed low power unlicensed spectrum for location-specific use (home, office, coffee shop) and high-power licensed spectrum for wide area mobile use. The two types of spectrum are complementary in the sense that the value of each is enhanced when the other is present.

A mixed regime of licensed and unlicensed use would not only be the most efficient allocation of spectrum, but it likely would increases auction revenue. First, the availability of the unlicensed spectrum would increase the utility of the licensed spectrum because licensees would have effective access to both bands as exemplified by how smartphones and tablets use both bands today. Second, having less licensed spectrum available would increase scarcity during the auction and thereby raise prices.

The Honorable Bob Latta

1. Can you expound a bit upon how the reverse auction will work under the incentive auction provisions of this bill? How do you think this will affect the revenue that the auction might produce - do you have an estimate for that?

The reverse auction identifies those TV broadcasters who are most willing to either give up or reduce their over-the-air broadcast rights. In particular the reverse auction determines for each region and each level of clearing, the price that must be paid to TV broadcasters in order to voluntarily clear the specified number of stations in the region. This information, together with the repacking algorithms and the information from the forward auction, jointly determine the supply and demand curves for mobile broadband spectrum. Given this information, the FCC can then make a regulatory decision about the best quantity to transact.

Without the information from both the reverse and forward auctions as well as the repacking possibilities, it is not possible to precisely estimate either the welfare gains or the revenue gains from the auction. Nonetheless, the recent explosion in demand for mobile broadband fueled by the latest smartphones, tablets, and laptops suggests that the welfare gains would be a multiple of $10 billion dollars. This is difficult to translate into auction revenues, which depend on the shape of the supply and demand curves and lumpiness in quantity choices that are dictated by technologies.

One thing is certain: the auction will be revenue positive. There is no possibility that the payment to TV broadcasters would exceed the amount received from mobile operators.

The Honorable Cliff Stearns

1. If the FCC auctioned all of the spectrum it reclaimed, on a voluntary basis, in the TV band, how much revenue do you think could be generated?

The incentive auction is better thought of as a simultaneous determination of the supply and demand curves for contiguous blocks of spectrum. This simultaneous determination is how the FCC can guarantee that the auction is revenue positive and that the quantity that is transferred to mobile broadband is consistent with the needs of mobile operators.

Because of equipment economies of scale and the requirements of the emerging technology (LTE), it likely makes sense for the quantity that is transferred to mobile broadband to accommodate the same whole number of 2x10 MHz blocks in each region of the country. This allows a consistent band plan across the nation, which is important in creating interoperable devices that work across all blocks throughout the country. This lumpiness on the demand side will create a positive spread between what the mobile operators pay and what the TV broadcasters receive. The auction revenues depend on that spread. A precise estimate cannot be made. However, a reasonable guess is that the spread would generate many billions of dollars in auction revenues.

The Honorable Charles F. Bass

1. I noticed in your testimony a footnote addressing the great difference between the FCC and CMS in the design and effectiveness of their auctions. As this committee has jurisdiction over parts of Medicare, and we all should share in the goal of improving the efficacy and efficiency of this program, what lessons can CMS learn in auction design?

There are important lessons for both CMS and for Congress in comparing the FCC experience with auctions and CMS' experience.

CMS can look to the FCC spectrum auctions as an example of an effective auction program. Key to the FCC's success was the early involvement of auction experts in the auction design process. This involvement of experts led to an innovative and successful auction program that has been adopted around the world.

Designing successful auction markets is far from trivial. It is essential to get the early involvement of auction experts to work in collaboration with industry experts and the government to develop the best market. Without this involvement, the auction program is much more vulnerable to failure. The CMS experience with Medicare auctions for durable medical equipment is a good example. The program is badly flawed and doomed to failure, if CMS does not take major steps to improve its design.

For Congress, the lesson is that different agencies have different capabilities with respect to the design and implementation of auction markets. The FCC is among the best and CMS is among the worst. As a result, Congress can give the FCC a great deal of freedom in designing and implementing incentive auctions. It is sufficient to outline the broad principles and objectives of the approach and let the FCC, together with experts and the industry work out the details. In contrast, CMS, at least currently, requires much more direction from Congress on how to design and implement an effective auction program for Medicare supplies.

References

Cramton, Peter, "700 MHz Device Flexibility Promotes Competition," July 2010. Argues that the carrier-specific band plans adopted by AT&T and Verizon Wireless for the 700 MHz paired spectrum will undermine competition. Filing to the FCC on behalf of the Rural Cellular Association.

Cramton, Peter, "Incentive Auctions," Working Paper, University of Maryland, July 2011.

Cramton, Peter, Evan Kwerel, Gregory Rosston, and Andrzej Skrzypacz "Using Spectrum Auctions to Enhance Competition in Wireless Services," *Journal of Law and Economics*, 54, forthcoming, 2011.

Cramton, Peter, "Spectrum Auction Design," Working Paper, University of Maryland, June 2009.

Letter from 112 economists to President Obama, urging legislation that gives the FCC explicit authority to conduct incentive auctions, 6 April 2011.

Letter from 244 economists to President Obama, urging legislation that reforms CMS' auction program for durable medical equipment, 17 June 2011.

ANSWERS TO CONGRESSIONAL QUESTIONS BY NATIONAL ASSOCIATION OF BROADCASTERS
SENATOR GORDON SMITH
HEARING ENTITLED: "LEGISLATIVE HEARING TO ADDRESS SPECTRUM AND PUBLIC SAFETY ISSUES"
August 23, 2011

The Honorable Marsha Blackburn

1. **Senator Smith, in response to a question I asked at the hearing, you indicated that NAB does not support a government-imposed mandate that mobile device manufacturers and/or mobile service providers include a mobile DTV chip in mobile devices used in the United States. Does NAB support a government-imposed mandate that mobile device manufacturers and/or mobile service providers include an FM chip in mobile devices used in the United States?**

ANSWER:

NAB is not asking for a government-imposed mandate that mobile devices incorporate an FM radio chip. While it is clear that the safety and well-being of America's citizens would be enhanced if every mobile device were radio-enabled, we continue to hope that no government mandate is necessary. More than 241 million Americans rely on local radio to provide news, entertainment, as well as critical information during times of emergency. With the cooperation of the mobile telephone industry, American consumers could enjoy convenient access to their favorite free radio stations over their mobile phone handsets. In addition to news, music and entertainment, expanding the universe of radio-enabled mobile phones would save lives. This spring's tornado outbreaks in the South are recent examples of situations where radio was the only source of emergency information when mobile networks were down because of congestion or tower damage. Radio over mobile phones is not dependent on cellular infrastructure.

More than 700 million radio-enabled mobile phones have been sold worldwide, where mobile phone carriers do not exercise exclusive control over handset manufacturing, compared to only about ten percent of mobile phones sold in the U.S. It is surprising to broadcasters that despite demonstrated consumer demand, fewer than 30 models of the hundreds of mobile phone models currently available in the market currently include free, over-the-air radio service as an optional feature. Recently, we have been encouraging the public to become more vocal with the carriers. In addition, broadcasters continue to work with mobile phone carriers toward expansion of the radio-enabled mobile phone market. Hopefully, these efforts will encourage the carriers. We greatly appreciate any additional encouragement from Congress and the Federal Communications Commission toward the goal of making radio-enabled mobile devices readily available for the public.

The Honorable Henry Waxman

1. **The Republican discussion draft identifies 40 MHz of spectrum between the frequencies of 2070-2110 MHz for auction. I understand that the band, known as the Broadcast Auxiliary Service (BAS) band, is currently used by broadcasters for electronic newsgathering services and by the U.S. government for space and satellite operations. Does NAB support auction of this spectrum?**

ANSWER:

NAB does not support the auction of additional broadcast auxiliary service (BAS) spectrum. This spectrum is already highly congested and heavily used. The 2 GHz BAS band is divided into seven channels that are shared by all television broadcasters and television broadcast network entities. These channels are used to transit live news events, reports and other programming from the field. In addition, this spectrum is also used by cable television systems. Further, the 2 GHz broadcast auxiliary spectrum has already been recently reduced by 29.1% or 35 MHz. This spectrum reduction was the result of a 2003 FCC action to transition the 1990 to 2025 MHz portion of the BAS band to emerging technologies – most of which remain unused by these other services.

To reclaim this 35 MHz and retain the same number of channels (seven), the bandwidth of each BAS channel was reduced from 18 MHz to 12 MHz and transmissions were converted to digital modulation. All new BAS equipment and infrastructure had to be purchased and installed. While the original transition was scheduled to be completed in three years, the actual conversion took more than six years to accomplish and was only recently completed in August 2010. More than $750M and tens of thousands of work hours were expended by Sprint Nextel on this transition, in addition to the time and money spent by broadcasters. Reducing the remaining BAS spectrum by an additional 40 MHz would reduce the number of BAS channels by four, leaving only three channels for all broadcast operations.

From a technical perspective, the recent transition uses equipment incorporating state-of-the-art technology in digital video compression and transmission. It is very challenging to provide broadcast production quality video with typical BAS range and coverage using a 12 MHz channel at 2 GHz. It is highly unlikely that the same channel capacity would be possible with any further reduction in spectrum over the next generation of BAS equipment (let alone the 47% or 40 MHz suggested).

2. **If some broadcasters exit the market voluntarily as a result of an incentive auction, would the demand for electronic news gathering services be likewise reduced?**

ANSWER:

It is highly unlikely that the demand for newsgathering and other use of broadcast auxiliary frequencies would be reduced due to an incentive auction. The broadcast auxiliary band is used by networks and TV stations in a market for newsgathering, sports and program production, and other major events. NAB anticipates that few, if any, of the TV stations and networks that engage in these activities and offer these programming services to their viewers will participate in an incentive auction. Moreover, the use of spectrum for live reporting has been steadily increasing over the last decade. We expect that trend will continue after an incentive auction.

3. **Both the Republican and Democratic discussion drafts create new funds to cover costs associated with relocation or, in the case of the Democratic draft, additional costs associated with modification of a broadcaster's spectrum usage rights. Do you believe such language is sufficient? Do you think the Democratic draft provides sufficient funding to cover relocation costs?**

ANSWER:

First, I would like to thank Congressional leaders on both sides of the aisle for carefully considering the substantial impact any incentive auction and subsequent repacking will have on those many stations that choose not to participate. As you are aware, relocating a broadcast station to a new channel involves much more than a simple turn of a dial. It involves major new equipment purchases, including new transmitters, potential tower upgrades, specialty labor from a limited number of companies capable of installing new transmitters or making tower upgrades, and the likelihood that some stations could be off-air for weeks during a transition.

Projecting how much it will cost to compensate television stations forced to move channels after an incentive auction is very difficult because there are so many variables at play. The simplest answer is that the more stations that need to move, and the further those stations need to move, either geographically or within the band, the more it will cost to compensate them. Therefore, as an initial matter, NAB believes that all efforts should be made to limit disruption of the broadcast band after an incentive auction.

However, understanding that some relocation may take place, NAB staff, including our engineers, have developed cost estimates for various scenarios that we hope will provide Congress with some guidance going forward. For example, if 120 MHz is sought to be recovered – as suggested in the National Broadband Plan - all stations currently operating on TV channels 31 to 51 would have to go off the air or be moved to a new channel. There are currently 672 full power television stations operating on these channels in the continental United States. This represents almost 40 percent of all full power TV stations. In addition, there are 209 Class A television stations and 3,214 low power television and TV translators on these channels. Additionally, to make room for those stations currently on channels 31 to 51 that choose to stay on the air – which we anticipate will be the vast majority - a large number of the television stations operating below channel 31 would also have to change channels. Recent NAB studies estimate that about 800 to 1100 of all TV stations would have to change channels to accommodate stations on channels 31 to 51, and the stations that are likely to be relocated are located in major markets and are therefore likely to have higher relocation costs. We also note that approximately 60% of television stations share transmission facilities and channel changes to any station sharing that facility may require concomitant changes (e.g., new antennas, filters, etc.) to other stations sharing that facility. We estimate that the cost of relocation would be about $2.5 billion dollars, more than what is being proposed in any of the legislative drafts

In addition to reimbursement, stations require sufficient notice and time to make technical changes to their television facilities. There are a limited number of manufacturers of broadcast equipment, tower crews, environmental assessment personnel, etc. Certain channel changes will require coordination with Canada and Mexico, a process that has already proved lengthy during the original DTV transition. In addition, in many areas, access to and construction of facilities is limited by weather and other conditions.

Our cost projections are just rough estimates, and probably conservative. They do not account for the lost revenue a station may suffer if it must go dark for weeks or months, as many stations would. Based on these estimates, we believe that a $1 billion cap on compensation for relocation of broadcast stations will not be sufficient in the event of a major repacking.

4. **The Republican draft also includes a provision that allows television broadcasters to obtain regulatory relief in lieu of reimbursement for relocation costs. Do you think this provision will be attractive to broadcasters? If so, what specific examples of regulatory relief do you believe**

your members might seek in lieu of financial compensation for the costs associated with repacking?

ANSWER:

As we note in the answer to your previous question, relocation costs for some broadcasters in the event of an incentive auction and subsequent repacking of the television band could be substantial – greater than $5 million per station, in some cases. For those broadcasters, it is highly unlikely that regulatory relief alone, without monetary reimbursement, would be enough to offset the costs of a forced relocation. In other cases, however, some broadcasters may find regulatory relief in lieu of some reimbursement an attractive option. We applaud Congressional leaders for their creativity in this regard. We note that the Republican draft allows broadcasters to choose regulatory relief "in lieu of reimbursement for relocation costs." To ensure this is a viable option for broadcasters and the FCC, we suggest that the language of the bill make two things clear. First, the option to accept regulatory relief lies solely with the broadcaster. It should not be mandated in lieu of reimbursement. And second, in some cases, it should be an option to accept regulatory relief in lieu of *some* reimbursement costs. Making it an all-or-nothing proposition substantially reduces the flexibility and usefulness of the provision as a mechanism to reduce the overall cost of the relocation.

As to specific examples of regulatory relief, there may be options for some relief from ownership restrictions or from regulatory or licensing fees that appeal to some broadcasters. We stress, however, that the "value" of that relief should be set by the broadcaster choosing the option, as the offset value of any regulatory relief would vary from broadcaster to broadcaster.

The Honorable Cliff Stearns

1. **Can you speak to why it is important that the FCC have the authority to conduct one incentive auction in the broadcast spectrum? What is the harm in allowing the Commission open-ended auction authority?**

ANSWER:

First, an incentive auction and subsequent repacking will create substantial disruption for TV viewers. Even if the repacking is done correctly, NAB studies show that as many as 1,100 full power television stations would need to move channels to accommodate a reduction of the broadcast band as recommended in the National Broadband Plan. Because those moves could require broadcasters to substantially change their facilities, some local stations could be forced to go dark for weeks or even months during any relocation. Unlike during the DTV Transition, broadcasters will not have the luxury of a second channel during this relocation. Furthermore, broadcasters will have to engage in another consumer education campaign to alert viewers that many stations will be moving channels and viewers will need to re-scan for those stations after the relocation and perhaps purchase a new over-the-air antenna.

Second, an incentive auction, or more accurately the threat of multiple incentive auctions, creates uncertainty in the marketplace; and uncertainty stifles investment. This can happen on a number of levels. At the most basic level, potential buyers of broadcast stations may be reluctant to invest millions of dollars in a station if they lack confidence on return of their investment. While the possibility of an incentive auction could attract investors, there remain too many variables, both at the legislative stage and the regulatory stage, which could limit how much broadcast stations might receive in an incentive auction. More importantly, however, is the investment impact the threat of multiple incentive auctions will have on the many broadcasters that elect to stay on the air and serve their communities. The threat of an incentive auction means the threat of lost spectrum, the threat of a diminished service and the threat of fewer overall viewers. Collectively, these threats will affect how investors view the industry as a whole. The promise of Mobile DTV is a perfect example. To develop Mobile DTV, broadcasters need spectrum. And technology companies that will develop Mobile DTV technology want certainty that the spectrum their products require will not be taken away. No rational investor will invest billions of dollars in a technology whose necessary resource could be substantially reduced multiple times within 5-10 years.

2. **Can you explain what it means to replicate a broadcast station's "service area"? Is that simply protecting the population that the station serves, or is it something more?**

ANSWER:

Broadcasters are simply asking to be able to continue to serve their current viewers and audience. Our viewers are entitled to receive the same digital services, such as high definition TV and multicasting, they are currently receiving today in the event of relocation. They should not lose the services they currently receive as the result of the Commission redefining or changing broadcasters' service area or forcing broadcasters to share their channel bandwidth. Moreover, they should not be required to purchase new antennas such as would be necessary if a broadcaster is forced to relocate from a UHF channel to a high VHF channel (TV channels 7 to 13) or from high VHF channel to a low VHF channel (TV channels 2 to 6). Replicating their stations' service areas is the only avenue broadcasters' have to ensure that their current viewers are not disfranchised in this process. We also believe that viewers should be entitled to receive the new and innovative digital services, such as Mobile DTV, that are being implemented by broadcasters' today and in the near future. Reallocation from UHF to VHF would impair current and future Mobile DTV services.

3. **Many of the issues broadcasters support in the draft before us today (like signal protections and channel relocation) seem to be issues that could be left to the Federal Communications Commission to resolve. Why should this Committee build those protections into this legislation?**

ANSWER:

Incentive auctions and repacking will have a substantial impact on TV viewers, your constituents. It represents a major shift in American telecommunications policy. For that reason, Congress will and should play an important role in how it is implemented. The provisions of the bill we support ensure that TV viewers are protected. The bill would still provide the FCC, as the expert agency, with the flexibility it needs to conduct successful incentive auctions without major limitations. But it is imperative that Congress provide specific direction in regards to the repacking of the broadcast spectrum to make it clear that the interests of your constituent TV viewers are paramount and must be a significant part of the policy choices that guide FCC decisions. We believe the provisions that we support provide that necessary guidance.

Subcommittee on Communications and Technology
Legislative hearing to Address Spectrum and Public Safety Issues
July 15, 2011
Additional Questions for the Record
Response of Michael Calabrese, New America Foundation

The Honorable Bob Latta

1. You say in your testimony that unlicensed bands should not be subject to auction. However, is it equitable for licensed providers to pay huge sums to clear the broadcasters or other users from their bands, only to have some portion of those bands then turned over for unlicensed use by providers who have no financial "skin in the game"?

Under the incentive auction methodology proposed in the Majority's Discussion Draft, the "Forward Auction" [Section 103(c)] of available spectrum to new licensees and the "Reverse Auction" [Section 103(a)] to "determine the amount of compensation that each broadcast television licensee would accept in return for relinquishing some or all of its spectrum usage rights" are completely independent stages of the process. Like any past spectrum auction, the bids for licenses put up for auction will determine how much the new licensees pay – and this is completely independent of the Commission's decision to select which reverse auction bids by broadcasters will be accepted for payment from government revenue. In other words, the wireless carriers will bid on and pay only for the spectrum they acquire, like any other auction. However, unlike some other auctions, the winning bidders will not need to compensate the incumbent licensees for either their spectrum or for involuntary relocation costs, since the government is paying this cost from the overall pot of auction revenue that would otherwise all flow to the Treasury.

This is a reversal of the position that Congress took in June 2002, when it passed legislation (signed by President Bush) that canceled the initial 700 MHz auctions (channels between 60 and 69) because the FCC had adopted an incentive auction mechanism that would have channeled as much as two-thirds of the total auction revenue (an estimated $10 billion at that time) from the Treasury into a "broadcaster clearing fund" to be divided among the stations that agreed to turn off their analog signal early and relocate their digital allotment below channel 51.[1]

With respect to unlicensed spectrum, the bidders in the Forward Auction will not pay any additional amount to compensate broadcasters who give up spectrum, or who are relocated off spectrum, that is reallocated for unlicensed use (as a replacement for unlicensed spectrum that is auctioned or reassigned to broadcasters as part of the repack). As noted in the question just below posed by Rep. Eshoo, the bipartisan bill (S. 911) reported out of the Senate Commerce Committee has language that clarifies that the Commission can use a small portion of the pool of auction revenue to compensate a broadcaster for relocation costs for the purpose of ensuring that one or more TV white space channels remain available in a market. If this expense occurs, it will likely be in a handful of the most congested metro markets where unlicensed access to TV band spectrum could be squeezed out entirely, thereby destroying the scope and scale of national markets for "Super WiFi" chips, devices, applications and services. While this cost may reduce to some degree the net auction proceeds that flow to the Treasury, this is always the case with unlicensed spectrum. For example, the decision not to auction the currently unlicensed 83.5 MHz at 2.4 GHz – once referred to as the "junk bands" but now as the WiFi band – is a net short-term cost to the Treasury, but a huge boon to the economy and to innovation, competition and the quality of life of most homes, businesses and nonprofits that network wirelessly over WiFi.

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[1] *See, e.g.,* Michael Calabrese, "The Great Airwaves Robbery: The FCC's Decision on Channels 60 – 69 Could Transfer $10 Billion from Taxpayers to Broadcasters," New America Foundation, Issue Brief, Spectrum Series #2 (November 2001).

Finally, with respect to "skin in the game," as I suggested in my testimony, all firms and households are likely beneficiaries of unregulated spectrum access on TV white space. The chip and device makers, as well as application developers and Internet companies, do not sell wireless Internet access–it's neither their business nor expertise. They are only indirect beneficiaries, like trucking companies with respect to interstate highways – or shipping companies with respect to open access to oceans and waterways. Among the "providers" (ISPs) that use unlicensed spectrum as a direct alternative to licensed spectrum, the most notable are the roughly 2,000 WISPs that deliver fixed broadband access to rural, remote and small town areas across the country that mostly lack any wired broadband coverage. These mostly very small businesses cannot afford to purchase mother-may-I licenses from the FCC and sprung up on unlicensed bands – like so many other innovations – because it was a free and largely unregulated public resource.

Aside from WISPs, by far the largest single user of unlicensed spectrum at present is AT&T Wireless, which has established more than 24,000 free wireless hotspots, as well as growing number of wide area "hot zones," to offload customer data over WiFi onto local wired networks, thereby relieving congestion and improving the overall quality of service of its licensed service. Because of exploding mobile data demand, the ability to efficiently re-use unlicensed spectrum many times over without the need for centralized infrastructure will prove to be a great benefit to the carriers who pay for exclusive-use licenses, as well as to virtually every other business and household who can access this public resource without paying a middleman.

The Honorable Anna G. Eshoo

1. **How would the TV white spaces be impacted by the repacking process proposal in the Majority's discussion draft?**

The Majority's Discussion Draft is very much focused on protecting local broadcasters and auctioning licenses to wireless carriers. However, another critical public interest in the TV bands needs to be safeguarded as well: unlicensed use of TV White Space channels. If the Commission undertakes a very aggressive repacking of the TV band – and involuntarily relocates stations from the upper UHF channels to the more limited number of available station slots below Channel 37 – a number of the largest, most congested metro markets (such as New York, L.A. and San Francisco) could be left without a single TV white space channel for mobile use. This could occur even when there are vacant TV channels available in a market below Channel 21, since under the rules mobile unlicensed devices (so-called personal/portable devices) are only permitted to operate above channel 20.

There is no question that an incentive auction and band repacking process that does not permit the FCC to maintain unlicensed channels in each of the nation's 210 local media markets would squander the very substantial investments being made in "Super WiFi" technologies and America's lead in both unlicensed and dynamic spectrum technologies. It is not sufficient to maintain unlicensed access to 'white space' in only rural markets, since without the scope and scale of national markets the costs will be far higher and the degree of innovation much lower.

With this in mind, I am concerned that the Discussion Draft does not include language, such as the language in the bipartisan Senate bill (S. 911), that instructs the Commission to make every effort to repack the band so that unlicensed channels remain in every market and thus nationwide. We believe that the ultimate House bill should include clarifying language along the lines of the "Unlicensed Spectrum" provision in S. 911, which states: "A portion of the proceeds from the competitive bidding of the frequency bands identified in the prior sentence may, if consistent with the public interest, be disbursed to other licensees, for the purpose of ensuring that unlicensed spectrum remains available in these frequency bands, nationwide, and in each local market." In practice, this provision clarifies that the Commission can use a small portion of auction proceeds to compensate a broadcast station for relocating in order to ensure that one or more TV white space channels remain available in a market. For example, if the channels above Channel 37 are cleared for auction, and if relocating broadcast station licensees would eliminate the remaining white space for mobile broadband devices between channels 21 and 36 in a congested metro market, this provision could allow the FCC to optimize the repack by compensating a licensee to move to a channel below 21, thereby preserving an unlicensed channel in the frequency range permissible for mobile broadband.

The Honorable Henry Waxman

1. **Please respond to Mr. Gutman-McCabe's preference, as expressed in his written testimony, that Congress reallocates the identified bands below 3 GHz for exclusive commercial use.**

In his testimony, CTIA's Chris Gutman-McCabe's preference is stated in the context of raising the concern that Section 101(c) of the Majority's Discussion Draft "gives NTIA considerable discretion to promote spectrum sharing rather than spectrum clearing" and "creates disincentive for NTIA to clear two key bands - 1670-1710 MHZ and 1780-1800 MHz - for commercial use." The paradox is that while the vast majority of spectrum assigned for federal use lies fallow in most locations and at most times – leaving tremendous communications capacity unused – most of the federal systems cannot be moved or replaced in the near future. The reality is that there are very few federal bands that can be cleared completely, or within a five-to-ten-year time frame, for the purpose of auctioning the spectrum for exclusive commercial use.

Despite the abundance of unused spectrum capacity, there is a looming limit to the number of frequency bands below 3 GHz that can be reallocated, by auction or otherwise, to exclusively licensed use. As a result, while the traditional carrier business model will demand more and more exclusive-use spectrum in the short-run to meet surging mobile data demand, it should be equally clear that this model is not sustainable longer term. The Public Interest Spectrum Coalition believes that it is not only impractical, but also ultimately anti-consumer, to attempt to meet the growing demand for mobile data consumption solely through traditional reallocations of exclusively licensed spectrum by auction. Advancing the public interest in promoting pervasive connectivity, innovation, and consumer welfare suggests that the Commission also should lay the groundwork for complementary spectrum access models that focus on enabling shared, dynamic access to unused and underutilized bands. For example, both consumer welfare and spectrum efficiency would be enhanced by cognitive and cooperative devices that enable hybrid networks, which carry most mobile data short distances, at low power, over unlicensed or other shared spectrum and through consumer-provisioned backhaul.

Opening unused or underutilized spectrum capacity for shared/commercial access ultimately must be addressed on a band-by-band basis – although even this approach can prioritize certain categories of spectrum where the approach seems most promising and logical. As the National Broadband Plan recommended, the most immediate category of spectrum that should be made accessible is FCC-held spectrum. Another immediate focus for this effort, in collaboration with NTIA, should be the identification and analysis of federal bands that NTIA has determined cannot be cleared for reallocation by auction, but which could under certain stringent conditions (*e.g.*, exclusion zones, low power limits) be opened for shared access by the private sector. A third category that the Commission should address in a future NPRM is "white space" on licensed bands that have not been built out in substantial portions of the country. Opportunistic access using a geo-location database addresses the vexing problem of valuable licenses that are not built out, particularly in rural areas, by moving to a "use it or share it" condition (rather than a more draconian and rarely enforced "use it or lose it" rule).

2. The Republican draft includes a provision that allows television broadcasters to obtain regulatory relief in lieu of reimbursement for relocation costs. Do you have any concerns about the language of that provision?

The "Regulatory Relief" provision in the Majority's Discussion Draft is strangely reminiscent of the indulgences that the pre-Reformation Catholic clergy sold at their discretion to well-off sinners. The provision literally states (at pp. 18-19) that "[i]n lieu of reimbursement for relocation costs" television station licensees may be granted, at the Commission sole discretion, a "waiver or modification . . . of any provision of law administered by the Commission, or any regulation of the Commission promulgated under any such provision." The provision would set a disturbing precedent of putting the law up for sale – and giving a federal regulatory agency untrammeled discretion to decide which companies could be exempted from the laws and rules that others must obey, as well as how much they will pay for that privilege. While it's conceivable that Congress could identify some particular statutory provision or FCC rule that could be waived or modified in lieu of reimbursement for broadcaster relocation costs, granting the Commission blank check discretion to waive or modify "any provision of law" or "any regulation" is without precedent and dangerously overbroad.

3. You stated in your testimony that an auction model for unlicensed as required under Sec. 104 of the Republican draft will likely inject uncertainty into the auction process and undoubtedly lower the score that CBO would put on what would be unpredictably contingent auctions. Please elaborate.

I stated that auctioning "unlicensed" spectrum – such as the Wi-Fi band (at 2.4 GHz) or the new Super Wi-Fi spectrum (TV White Spaces) – is impractical as a revenue raiser *and* could even reduce the net revenue from auctions for exclusive licenses.

The principal reason that the auction mechanism required under Section 104 of the Majority's Discussion Draft could reduce overall spectrum auction revenues is because it would create enormous uncertainty about whether a band of frequencies will end up a geographic patch quilt of licensed and unlicensed, subject to different technical rules and with no ability to later create a nationwide or possibly even a regional service. Auctions have never offered a nationwide license, but rather licenses that correspond to local economic areas or, at the largest, multi-state regional areas. The auction proposed in Section 104 could lead to the same frequency bands being exclusively licensed for high-power use in some areas of the country, and open for unlicensed, non-exclusive use at low power levels in other parts of the country. Smaller geographic licenses help rural areas and promote competition – but since some local areas will end up licensed and some unlicensed, these frequency bands could never again be aggregated nationwide or possibly even regionally.

Both licensed and unlicensed bands have greater value to potential bidders when economies of scale for devices and services are likely because uses are harmonized not only domestically but often internationally as well. As CTIA's Chris Guttman-McCabe stated in his testimony with respect to the value of global harmonization of the 1755-1780 MHz, the use of common technologies across a band "would reduce the uncertainty associated with creating devices and software for use in those bands, with the likely effect that such a pairing would be highly valued by bidders."

From a CBO perspective, auction revenue would also become more difficult to project because Section 104, as written, gives the FCC the discretion to decide whether to make unlicensed an option for any particular auction (or set of bands within an auction). Although I believe that the 'free rider' and 'collective action' problems outlined in my testimony make it unlikely that potential bidders for unlicensed will ever prevail in such an auction, the uncertainties noted just above should require CBO to apply a discount factor to what might otherwise be a more traditional auction for exclusively-licensed spectrum under definite and consistent service rules.

4. Please briefly discuss the current progress into the research and development of white space devices. When are you expecting the FCC to begin its device certification process for these new devices? When do you expect these devices to be available in the marketplace?

The FCC has now approved ten companies (adding Microsoft just this month) to administer competing geolocation database solutions for managing unlicensed access to unused TV band channels without interference to broadcasting. These companies obviously anticipate a mass market – both here at home and worldwide – as the unprecedented TV Bands Database tool becomes accepted in the U.S. and around the world to manage band sharing, both unlicensed as well as for secondary market leasing. The Wi-Fi Alliance is projecting that mobile device certification will begin no later than 2013. The companies affiliated with the Wireless Innovation Alliance have reported the following progress on the ecosystem of both fixed and mobile broadband standards, chips and devices:

Standards Work: – Timing Varied, but Generally Settled by Mid 2012

- 802.11af standard modifying Wi-Fi standards to enable low-power (personal/portable) white space device access. This should be done by the second calendar quarter of 2012. 802.11af will likely be the most widely adopted white spaces standard.
- 802.16 standard enabling WiMax use of the TV white spaces. This could be for higher power white spaces connectivity. This standard was published in 2010.
- 802.19 standard is focused on enabling the coexistence of different technologies (like Wi-Max and Wi-Fi) using white spaces in a particular geographical area. This is expected to be finalized this year.
- 802.22 standard has just been finalized and published. It is focused on support higher-power fixed TV white spaces devices for wide area networks, but using sensing technology.

Chip Work: It is expected that chips for consumer devices will be available by mid-2012.

Device Certification: Could begin as early as Q4 of 2011.

- FCC device certification process will begin as soon as TV white space databases are authorized – possibly fourth calendar quarter of 2011.
- WiFi Alliance is projecting that a white spaces device certification program will be in place by YE2012.

Devices in Marketplace -- Year End 2012

- "White-Fi" devices leveraging the Wi-Fi (802.11af) standard expected to enter the marketplace by the end of 2012
- Devices leveraging non-White-Fi standards will also begin to enter the marketplace by the end of 2012
- Other white spaces devices – most likely fixed, higher-power devices focused on delivering last mile connectivity and using proprietary technologies – will begin hitting the market by the end of 2011 or early 2012. Prototypes devices are already being used in trials (manufacturers include Adaptrum, Airspan, KTS, Lyrtech, Neul, etc.).

5. Some opponents of setting aside unlicensed spectrum have stated that they support making more unlicensed spectrum available generally, just not in the broadcast band. Please respond to this argument.

The U.S. economy and society will benefit most from a balanced and complementary mix of licensed *and* unlicensed – along with access to both in frequency ranges with diverse propagation characteristics. The TV white spaces represent the last opportunity to obtain unlicensed spectrum below 1 GHz and without it many user scenarios will not emerge for the foreseeable future. While additional unlicensed access to frequencies above 3.7 GHz (such as in the 5 GHz band) could offer wider channels for fixed, short-distance applications such as video streaming, the propagation characteristics of TV white space spectrum is useful for entirely different purposes, including mobile networking and lower-cost rural broadband coverage.

Unlicensed spectrum below 1 GHz will be particularly important to rural and remote broadband coverage and affordability. For example, roughly 2,000 WISPs, as well as hundreds of Rural Local Exchange Carriers (RLECs), rely primarily on unlicensed spectrum to extend Internet connectivity to unserved and underserved areas. WISPA has long advocated access to the TV White Space because the unique propagation qualities allow it to cover far larger rural areas at lower cost. Today WISPs use increasingly crowded unlicensed spectrum at 2.4 GHz for last-mile connections and unlicensed at 5 GHz for backhaul. However, unlike spectrum at 2.4 GHz, the lower-frequency unlicensed spectrum below 1 GHz can cover far larger areas for the same capital cost (at least four to five times as much area) and can also penetrate foliage and walls, as well as bend around hills, in ways that spectrum above 2 GHz cannot.

Similarly, since unlicensed spectrum use is limited to very low power levels, TV white space will permit mobile, peer-to-peer, and machine-to-machine connectivity and innovation that would be far less robust and economic at higher frequencies that do not penetrate obstacles and/or cover larger areas at low power. For example, sensing networks in remote areas – or throughout a complex of buildings – could be more economical and reliable with an option to freely access unlicensed frequencies below 1 GHz. Moreover, as my testimony described, unlicensed spectrum is becoming increasingly complementary to licensed broadband services, particularly as a means of getting higher rates of throughput and offloading data from congested carrier networks. The leading carriers (particularly Verizon and AT&T) are building their LTE networks out on 700 MHz spectrum, which enjoys the superior TV band propagation characteristics described just above. An allocation of unlicensed spectrum is better able to be complementary and efficiently provide data offload and spectrum re-use if it has similar propagation characteristics.

> **6. Section 104 of the Republican discussion draft allows entities to aggregate their bids for unlicensed use of a spectrum band until such bids exceed the highest licensed bid for such use. How might users of unlicensed spectrum coordinate to aggregate their bids in order to outbid carriers interested in a licensed model?**

Section 104 of the Discussion Draft is modeled on a 2008 paper by three FCC economists who hypothesized a new type of "clock auction" where both carriers and a broad range of other companies would bid, with the high bids determining how much spectrum in the auction would be licensed or unlicensed. The FCC economists identified several potentially fatal problems with the implementation of this approach, one of which is what I called the "collective action" problem of aggregating bids among a sufficient number of the millions of businesses, households and nonprofit institutions that freely access unlicensed spectrum. I believe that incumbent carriers would always outbid even large firms and institutions that use unlicensed, unless their bids could be aggregated. Potential bidders include thousands of high-tech companies, tens of thousands of other firms (hotel and retail chains) and non-profits (schools and hospitals), as well as tens of millions of employers and households whose bids should be aggregated since they profit from unregulated access. Who would do this (the FCC?) and how?

Most unlicensed operators, such as the nation's more than 2,000 small business WISPs, will be unable to raise the capital to bid on shared, non-exclusive use. And even large high-tech firms that benefit indirectly from consumers' unlicensed use of the airwaves (on devices such as iPhones and iPads) have stated in FCC filings and letters to Congress that they are not network operators and have no intention of bidding to purchase unlicensed spectrum, particularly not if they would be subsidizing other current and future competitors (this is the separate "free rider" problem that afflicts the proposed auction mechanism in Section 104).

The Draft also leaves critical implementation issues unanswered. Must bids be proportionate to future use? Will be FCC register, convene and coordinate what could be thousands of bidders with extremely diverse use cases in mind? If not, who will? There will also be companies that decide to deliver products and services years after the allocation and that would not participate in the auction.

7. In his testimony, Mr. Guttman-McCabe expressed CTIA's support for Section 105 of the Republican discussion draft, citing the 700 MHz C Block auction as evidence that the "imposition of regulatory encumbrances reduces competition at auction and the revenue derived from auction." Do you agree?

The proceeds from the 700 MHz C Block licenses (all acquired by Verizon Wireless) were lower on average primarily for reasons of auction design that had nothing to do with the condition imposing basic *Carterfone* consumer protections on the licensee. Before explaining why, it's important to note that a whole variety of regulatory conditions that serve the overall public interest could indeed reduce the price that certain companies are willing to pay at auction for spectrum. For example, build-out requirements that ensure the spectrum is not warehoused and that at least some rural and small town areas receive service are public interest obligations that reduce the option value of the license to carriers who would assuredly prefer no requirements at all. Similarly, the relative size of the license areas auctioned can reduce total auction revenue even as they serve public interest purposes to promote competition, to facilitate service by rural and regional carriers in underserved areas, or to spur deployment of a new technology such as LTE. Both the auction design rules and the service requirements on licenses require a careful balancing of policy objectives, only one of which is net proceeds to the Treasury. In fact, Congress had the wisdom to state explicitly in Section 309(j) of the Communications Act of 1996 that the Commission must set auction policy to serve the overall public interest – and not to maximize one-off auction revenue.

With respect to the C Block auction, critics of the consumer protection conditions the FCC imposed on the 22 MHz C Block – which requires the winning bidder to allow subscribers to attach any device, run any application and access any content on the Internet that does not harm the network – argue that government revenues could have been higher. The Phoenix Center published a study attributing the lower average revenue received for C Block licenses purchased by Verizon nationwide to these Wireless *Carterfone* service rules. CTIA and other industry advocates pointed to this to support their views that auction policies that promote consumer protection and competition sacrifice auction revenue. In reality, a combination of factors unique to the C Block auction would likely have led to lower average winning bids even in the absence of the *Carterfone* consumer protection conditions. New America Foundation commissioned a study by economist Gregory Rose that demonstrates that the Wireless *Carterfone* conditions were just one of four key differences between the C Block licenses and others in the 700 MHz auction.[2] The following summary is adapted directly from the 2008 Rose paper:

Among those key factors was the enormous geographic size of the licenses in the C Block, which made the licenses a good fit for only a small subset of bidders in the auction (principally Verizon and AT&T). The eight regional licenses in the C Block each covered an area more than 150 times as large as the smaller market licenses in the B Block. As a consequence, the pool of potential bidders for C Block was significantly smaller than for the other blocks, because those licenses required very specific business plans. They offered economies of scale only to those companies capable of utilizing them (viz., the few national and large regional carriers in the auction) and required significantly more resources to achieve deployment (and meet build-out requirements) than licenses in the B Block. Exacerbating this was the presence of Google in the auction, which bid up to $4.6 billion on the entire C Block nationwide before dropping out.

Another very substantial reduction in C Block revenue resulted from the unusual combinatorial or "package bidding" rules that applied only to the C Block and their interplay with eligibility to continue bidding round-by-round on the A,B, and E blocks. Package bidding had the effect of rendering certain higher bids ineligible or preventing bidders from renewing lapsed bids in the auction. For example, in the Northeast regional license, Verizon was able to win the license in Round 29 with a bid of $502.8 million, which was nearly $102 million less than Alltel's bid of $604.6 million. However, because of the intersection of the combinatorial bidding rules with the eligibility and activity rules – and the formula by which minimum acceptable bids were calculated – Alltel's bid did not set the minimum acceptable bid and Alltel lacked eligibility to reinstate its lapsed bid. A similar situation occurred with the West regional license, where Verizon won the license in Round 30 with a bid of $319. 8 million, which was less than half as much as an earlier $683.9 million by Bluewater Wireless in Round 6. As before, due to the same intersection combinatorial bidding and other rules rules, Bluewater did not have sufficient eligibility to reinstate the lapsed bid.

In addition, more onerous buildout benchmarks exclusive to the C block increased the capital costs and risks for potential winning bidders relative to the licenses in the other blocks. The paper also statistically tests the impact of *Carterfone* conditions by utilizing the Phoenix Center's own data and econometric models, further demonstrating that wireless *Carterfone* service rules did not significantly depress C Block prices in the 700 MHz auction.

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[2] Dr. Gregory Rose, "The Impact of Wireless *Carterfone* Conditions on C Block Auction Revenue: Why the Phoenix Center is Wrong," New America Foundation, Wireless Future Program Working Paper Series (June 2008).

8. Commissioner McDowell of the FCC recently stated that a carve-out for unlicensed white spaces spectrum would "add[] a positive and constructive chaos to the marketplace." Do you agree with the Commissioner's statement that unlicensed spectrum, and white spaces in particular, promotes competition.

Commissioner McDowell – along with former commissioner Meredith Baker and former Chairman Michael Powell, who initiated the TV White Space unlicensed rulemaking – has been a steadfast champion of the many benefits of unlicensed spectrum in the TV bands below 1 GHz and its potential impact for innovation and competition in particular. It is important to keep in mind that the expert agency has twice voted 5-0 on a completely bipartisan basis to open the unused TV band channels (white spaces) for unlicensed use.

If the evolution of Wi-Fi on unlicensed spectrum in the 2.4 GHz band is any indication, the "Super WiFi" that American high-tech companies are about to launch on the TV white space channels below 1 GHz will indeed inject some "positive and constructive chaos into the marketplace," as Commissioner McDowell stated. The ability of start-ups and innovators to compete without an expensive, mother-may-I license from the FCC lowers barriers to entry for competition and wireless IT integration in a wide variety of industries. Among the many ways that increased access to unlicensed spectrum for both firms and consumers will promote competition and innovation are the following:

- Low barriers to entry for innovation and start-ups, from exploding demand for WiFi and RFID, to the coming boom in monitoring and other machine-to-machine apps.
- Low transaction costs, particularly for start-ups, innovators & non-profits.
- Far more devices have been certified to use the 2.4 GHz unlicensed band (20,339 by one recent count) than in any other band (the FM band is second with 7,275 devices certified).
- More than 3,000 Wireless ISPs (WISPs) rely on unlicensed to bring broadband to unserved or under-served to some 2 million homes and small businesses in rural and small town areas (which is why WISPA supports TV white space).
- Over 1,500 Rural LECs (RLECs) use unlicensed to connect remote customers
- More than 20% of smartphone data traffic is routed over unlicensed spectrum (WiFi), an efficient offload Cisco projects will increase to 30% by 2015; this could be particularly key to smaller, spectrum constrained carriers in the future.
- AT&T, for example, has deployed more than 24,000 public 'hotspots' – and multi-node WiFi 'hot zones' – to relieve congestion on its licensed frequencies.
- Cable companies are partnering to blanket metro areas with WiFi, adding a mobile Internet option for their high-speed wireline customers.

Christopher Guttman-McCabe, CTIA-The Wireless Association®
Responses to Questions for the Record of the July 15, 2011 Hearing
before the House Subcommittee on Communications and Technology

The Honorable Bob Latta

1. How does adding more spectrum into the marketplace spur job creation? And how does the timeline of the incentive auction in this bill affect that?

Bringing additional spectrum to market is critical to spurring what we call the "virtuous cycle" of innovation. The availability of spectrum spurs network investment, and the availability of increasingly robust networks encourages manufacturers to build devices with enhanced capabilities. Increased network and device capabilities stimulate software developers to create new applications and content, which is adopted by consumers. As consumers want and expect more from their mobile services and devices, the cycle starts over again as wireless providers need access to additional spectrum. This "virtuous cycle" encourages innovation and job creation, as there are increased demands imposed at each level of the wireless ecosystem: provider, infrastructure vendor, device manufacturer, and software developer. This experience occurred as we made the transition from 2.5G to 3G service, and it is underway today as the industry transitions from 3G to 4G. Congress can help to continue this great American success story by moving spectrum into the marketplace as expeditiously as possible.

With respect to the timing of the incentive auction process contemplated by the Republican discussion draft, we believe it is reasonable that the Federal Communications Commission could be expected to complete repacking of the broadcast bands and an incentive auction of reclaimed spectrum within several years of enactment. Given the well-documented demand for additional spectrum, it would be our hope that the Commission would work to accelerate this process to the maximum extent possible.

2. The draft Upton/Walden bill proposes to use auctions to allocate spectrum for unlicensed use. Is this proposal workable, given that unlicensed spectrum is presumably available to multiple providers on a non-exclusive basis? How would it work?

Making use of spectrum under a traditional unlicensed model ("public commons") would certainly seem to be inconsistent with the basic premise of a spectrum auction, in which some clearly defined rights are purchased for the exclusive use of one licensee. However, the concept of a "private commons" has been seriously discussed for ten years or more, and in fact, the FCC adopted rules in 2004 to facilitate such uses. Unlike the traditional licensed approach, where a single party holds and controls the use of the spectrum, a private commons would permit non-hierarchical and peer-to-peer communications among users and devices that are not controlled by the licensee. Under this approach, a manufacturer or manufacturer consortium would acquire the spectrum license at auction in order to facilitate access to the spectrum by users that would purchase its devices. Using the auction process to assign spectrum to the company or companies that value it the most will allow Congress and the FCC to avoid having to pick "winners and losers" by choosing among competing providers or business models.

Christopher Guttman-McCabe, CTIA-The Wireless Association®
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3. Question for Michael Calabrese: You say in your testimony that unlicensed bands should not be subject to auction. However, is it equitable for licensed providers to pay huge sums to clear the broadcasters or other users from their bands, only to have some portion of those bands then turned over for unlicensed use by providers who have no financial "skin in the game"?

4. How would you respond to my question to Mr. Calabrese?

The Republican discussion draft would not require licensed providers to pay to clear the broadcast television band. Rather, as outlined in Section 103 of the discussion draft, expenses associated with clearance of the TV band would be paid out of a TV Broadcaster Relocation Fund, which would be capitalized from the proceeds of a commercial auction. The primary benefit of such a process is that commercial providers can bid knowing that they are bidding on unencumbered spectrum, which increases the value of that spectrum as well as the total proceeds from the auction. A secondary benefit is that it avoids the problem of having these companies pay to clear spectrum that they will not be able to use themselves.

To the extent that Mr. Calabrese and others wish to have some portion of the bands cleared through repacking and the incentive auction process set aside for unlicensed use, we understand concerns that those parties may be seeking to partake in the benefits of having the broadcast bands cleared without assuming any of the costs associated with clearing those bands. These concerns are exacerbated by the view that some of those parties arguing for unlicensed use of these bands are expected to use any such unlicensed spectrum to compete directly with the licensed auction winners, presumably with a cost advantage conferred (rather than earned) because they won't have had to bid for spectrum.

5. The "Common Carrier" bands of 11, 18, and 23 Gigahertz are a valuable national asset, but I've learned that applicants get the licenses for no more than a minimal processing fee. Do you think we could find a solution that encourages efficient use of this scarce spectrum that better monetizes this space to help reduce the deficit and promote increased efficiency in the 11, 18, and 23 GHz bands?

The 11, 18, and 23 GHz bands are used for fixed microwave systems including backhaul systems used to connect cell sites to a mobile communications network. These types of systems are especially important in rural areas where fiber-based communications facilities are not available. Licenses for fixed microwave bands do not confer on the licensees broad rights for use of the spectrum, as with other wireless licenses. Rather, the spectrum is limited to communications between two discrete points, which is why it is licensed on a site-by-site basis. Moreover, fixed microwave spectrum is shared among multiple licensees, even within a given geographic area. This means that its value is significantly less than that of spectrum used for commercial mobile use. Importantly, this shared licensing model for fixed microwave spectrum is important to ensure that the spectrum is used efficiently and available for use by any companies needing backhaul. The application of a nominal processing fee, as opposed to auctioning the spectrum, is appropriate for such licensing arrangements. While increasing the amount of such a fee could help reduce the national deficit, it would also increase the cost of providing broadband services, making it even more challenging to provide broadband services in rural areas.

The Honorable Cliff Stearns

1. Under the draft bill, the auction of 1755 to 1780 megahertz and other designated bands could be deferred for as long as 10 years. Shouldn't some of those auctions – particularly the 1755 to 1780 pairing with the AWS-3 block – be accelerated so that there is a steady stream of new spectrum coming online?

Absolutely. As indicated in my written testimony, CTIA believes that it is important to take all possible steps to bring high-quality spectrum to market as quickly as possible. The wireless industry is experiencing significant growth, and more spectrum will be needed to support that growth within the next five years. The 1755-1780 MHz band, paired with 2155-2180 MHz (AWS-3), is among the wireless industry's top priorities. Both bands are well suited for mobile broadband use, harmonized with other spectrum uses around the world, and immediately adjacent to spectrum already being deployed for broadband use in the U.S. If made available for commercial use, they could be implemented more quickly and with greater benefit to U.S. consumers than any other government band being considered for reallocation. CTIA urges Congress to take action to ensure that the 1755-1780 MHz band is reallocated for commercial use, paired with the AWS-3 spectrum, and auctioned within the next five years.

2. The Waxman-Eshoo draft delays the auction of the 1755-1780 MHz band until 2018 – and because it includes different deadlines for the auctions of that band and the 2155-2810 band, it may preclude it from being auctioned on a paired basis with the AWS-3 band. Would the value of both of these bands be enhanced if they were auctioned on a paired basis?

Yes. An April 2011 paper by Coleman Bazelon at the Brattle Group evaluated the potential valuations associated with the AWS-3 spectrum. Of all the possible options Bazelon evaluated, the pairing of 1755-1780 MHz with the AWS-3 band had the greatest potential valuation. I have attached a copy of Bazelon's paper to my answers and request that it be made part of the hearing record.

The Honorable Anna Eshoo

1. How do we make sure that public safety not only has access to a wide range of broadband-enabled devices but that these devices do not cost thousands of dollars each?

Christopher Guttman-McCabe, CTIA-The Wireless Association®
Responses to Questions for the Record of the July 15, 2011 Hearing
before the House Subcommittee on Communications and Technology

The use of commercial technologies by the public safety community and the formation of public-private partnerships will go a long way to ensure that first responders benefit from the innovation and competitive pricing structure that is the hallmark of the wireless industry.

These benefits will extend to public safety devices even if they operate on their own dedicated spectrum. Importantly, many public safety devices will not look the same (or cost the same) as commercial devices because they will need to meet some specialized requirements unique to public safety. While these devices may be significantly more affordable than public safety radios of the past, they should not be expected to match the prices of commercial devices that are produced for the mass market.

The Honorable Henry Waxman

1. During the hearing, you agreed with Chairman Walden that the Republican draft would increase revenue by prohibiting the FCC from imposing a condition on winning bidders that would limit the ability to manage their networks. However, Section 105 of the draft has four distinct prohibitions on the FCC: (1) a prohibition on restricting network management practices, (2) a prohibition on imposing a wholesale requirement, (3) a prohibition on restricting bidder eligibility through spectrum caps, and (4) a catch-all provision. Could you please clarify whether you support *all* of these provisions?

Traditionally, CTIA has opposed the imposition of restrictions on licenses offered at auction.

Regarding the specific provisions included in the Republican draft, CTIA believes the first two elements and the fourth element – preventing the imposition of restrictions on network management practices or wholesale requirements and the "catch-all" provision – have merit. While we believe that network management restrictions and wholesale mandates are unnecessary and inappropriate in all cases, the proper way for a member of the FCC who seeks to impose such rules is by broadly applicable rulemaking rather than by conditioning a license made available at auction. "One-off" policymaking of this sort distorts the marketplace; if a restriction cannot be justified on a broadly applicable basis, it probably should not be imposed at all.

With respect to the third proposed restriction, there is some divergence of views among CTIA's members with some members believe that eligibility restrictions are necessary to promote competition and other members viewing eligibility restrictions as inimical to enhancing scale economies in the wireless market. CTIA believes that if the objective is to ensure that there are multiple winners, and thus competitors, in each geographic region, the best way to achieve this objective is not through the imposition of restrictions but rather by bringing a multitude of fungible licenses to market simultaneously so that every company in a market that wishes to participate in an auction has an opportunity to win licenses.

Christopher Guttman-McCabe, CTIA-The Wireless Association®
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2. In your response to Chairman Walden, you appeared to indicate that CTIA's support for Section 105 is premised on maximizing the revenue generated at auction. Indeed, all four provisions of Section 105, as outlined above, are designed to eliminate possible encumbrances on licensees that some have argued would tend to reduce revenue. If you do not support all of these provisions, please explain why not.

I believe the question posed to me at the hearing focused on whether reducing risk through the imposition of certain limitations on the FCC's discretion would have a positive or negative impact on revenues at auction. Certainly, the data from recent auctions demonstrates that encumbrances depress both competition and revenue. The heavily conditioned 700 MHz "C block" saw fewer bids and sold for far less per MHz/POP than the unencumbered, but smaller 700 MHz "B block." Thus the most recent empirical data supports the notion that unencumbered auctions produce greater revenues. Additionally, the economic literature suggests that the imposition of regulatory mandates will reduce the expected profitability of any firm operating under those mandates, which in turn results in less investment by that firm. This theory, in concept at least, seems to be supported by the President, as he has issued two recent Executive Orders calling on Federal agencies to reduce regulation in order to spur investment and job creation. As Congress seeks to reduce the deficit and spark economic growth, it would seem that measures that reduce revenue and retard investment and job creation should be avoided whenever possible.

3. How much revenue do you think auctioning 195 megahertz (MHz) of spectrum in the 5 gigahertz (GHz) band, as identified by the Republican discussion draft, could generate?

Because CTIA has no experience with auctions in the 5 GHz range, I would hesitate to suggest how much revenue an auction in that space might generate. However, as I indicated in response to a question at the hearing, the 5 GHz band lies well outside the "sweet spot" for mobile services. For this reason, I do not believe that an auction of spectrum in the 5 GHz range should be expected to generate the sort of valuations we have seen in recent auctions of spectrum below 2 GHz.

4. Ms. Matsui has introduced the Spectrum for Innovation Act that would open up the 5 GHz bands for unlicensed indoor use. Identical language is included in the Waxman-Eshoo discussion draft circulated prior to the hearing. Do you have a position on that provision?

As noted in the answer to question 3, CTIA does not at this time see the 5 GHz band as being useful for mobile broadband service offerings. For that reason, it may be that the highest and best use of that band is to offer wireless backhaul or functionality (such as Wi-Fi) that enables users to extend the reach of their wired broadband connections and perhaps off-load their wireless service.

5. Does CTIA have a position on Section 104 of the Republican discussion draft?

It has not been a focus for CTIA, as we have argued consistently that the immediate priority should be to focus on identifying and bringing to market a significant amount of spectrum to be used for licensed wireless services. Recognizing, however, that some parties wish to have additional spectrum made available for unlicensed use, Section 104 provides a new and potentially interesting approach to doing so. To the extent that there are mutually exclusive visions for deploying licensed and unlicensed services in the same bands, a default to the auction process may allow Congress and the FCC to avoid having to pick "winners and losers" by choosing among competing providers or business models.

6. Mr. Calabrese argued in his testimony that auctioning unlicensed ignores the biggest beneficiaries of unlicensed: the wireless carriers that are increasingly relying on Wi-Fi systems to meet their spectrum demand. Do you agree?

While I genuinely doubt that Mr. Calabrese expressed the concern out of a desire to look out of the interests of wireless carriers, yes, wireless carriers are increasingly using Wi-Fi to off-load traffic. In our view, however, the key question is not whether unlicensed spectrum is helpful, but rather where it should be located and when it should be allocated. It is CTIA's strong preference that the initial bands below 3 GHz be used for licensed service.

7. Would your members be concerned that the new unlicensed model proposed by Section 104 of the Republican draft could introduce complexities and uncertainties into the spectrum auction process? How might this affect auction proceeds?

While any change in auction policy has the potential to introduce new complexities into the process, I am confident that the FCC can design an auction to accommodate a change of this nature if that is what Congress dictates. With respect to proceeds that might be generated by such an auction process, any result would depend on the bands auctioned and the auction and service rules applied. All things being equal, it would seem that the more interest there is in a particular band, irrespective of what business model might be employed post-auction, the higher the revenue generation potential associated with such an auction.

8. Section 101(c) of the discussion draft allows federal users to remain in the bands identified for auction if NTIA determines that federal use of such spectrum "is necessary to the critical communications related to the mission of the federal entity." You stated in your testimony that to the extent this language gives NTIA "considerable discretion to promote spectrum sharing rather than spectrum clearing" and it "creates disincentives" to clear the federal bands identified by the legislation for commercial use. Please explain how the language gives the NTIA too much discretion? Do you have any suggestions as to how the language might be improved?

Section 101(c)(1)(B) of the Republican discussion draft includes provisions that allow Federal and non-Federal users to jointly use the spectrum where such uses can be "coordinated by means of a database." However, the terms of such coordination are not included in the draft language, and are presumably left to NTIA to determine. Importantly, many of the current Federal uses of the spectrum would not be compatible with commercial mobile services. Consequently, if the proposed coordination database is simply used to protect Federal uses and to identify those areas that are excluded from commercial availability, then such a provision will act as an incentive for Federal users to remain in the band. CTIA believes that any spectrum reallocated for commercial use should be cleared of Federal uses to the greatest extent possible. Federal uses should only be allowed to remain in the band when there is no potential to relocate the Federal entity and where there are reasonable expectations about band sharing, e.g., where Federal and commercial uses are compatible or where demand for commercial services is expected to be very low.

9. What do you think about the sharing arrangement between federal and non-federal users contemplated in the bill? Is sharing through the proposed database appropriate for such prime spectrum?

NTIA's Office of Spectrum Management (OSM) is responsible for managing the Federal Government's use of the radio frequency spectrum. As a result, OSM focuses on protecting federal spectrum users and ensuring that sufficient spectrum will be available to meet current and planned future Federal communications capabilities.

From NTIA's standpoint, promoting spectrum sharing may be far more convenient for federal spectrum users than clearing spectrum for commercial use and relocating federal systems. CTIA remains concerned that by promoting sharing, the legislation reduces the likelihood that spectrum will be cleared for commercial use.

10. Has the wireless industry taken a serious look at repurposing this spectrum and the suitability of pairing it with the 1670-1710 MHz band as called for in the legislation?

While 1670-1710 MHz spectrum has excellent propagation characteristics, it is less attractive to the wireless industry than a contiguous 40 MHz block of spectrum in the 1755-1850 MHz band because it is not internationally harmonized for commercial use. As CTIA has testified, international harmonization reduces both 1) potential wireless broadband network infrastructure development and deployment costs and 2) the likely timetable for network deployment. Both factors reduce risks for potential spectrum auction bidders and increase their potential return on investment.

In examining the 1670-1710 MHz band, pairing options could have a major impact on spectrum valuations. The most attractive pairing option for this band option may be a contiguous 40 MHz block in the 2020-2110 MHz band. The discussion draft legislation would pair 1670-1710 MHz with 2070-2110 MHz. Currently, this Broadcast Auxiliary Service (BAS) spectrum is used primarily for remote point-to-point TV and cable relay services. Consistent with CTIA's views on the Commercial Spectrum Enhancement Act reported by the House Energy and Commerce Committee in the 110th Congress and CTIA's testimony in support of incentive auction authority for the FCC, auction proceeds should cover the full cost to federal agencies and private sector entities of clearing licensed spectrum for commercial use.

The Brattle Group

Cambridge
San Francisco
Washington
Brussels
London
Madrid

April 11, 2011

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20544

VIA ELECTRONIC FILING

Re: **EX PARTE PRESENTATION**

ET Docket No. 10-123
WT Docket No. 07-195
GN Docket No. 09-51

Dear Ms. Dortch:

Attached, for inclusion in the records of the above referenced proceedings is a study performed by the Brattle Group, entitled "The Economic Basis of Spectrum Value: Pairing AWS-3 with the 1755 MHz Band is More Valuable than Pairing it with Frequencies from the 1690 MHz Band."

If there are any questions regarding the study, please contact the undersigned directly.

Very truly yours,

Coleman Bazelon
Principal

Attachment

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The Brattle Group

The Economic Basis of Spectrum Value: Pairing AWS-3 with the 1755 MHz Band is More Valuable than Pairing it with Frequencies from the 1690 MHz Band

April 11, 2011

Coleman Bazelon
The Brattle Group, Inc.

Disclaimer: The views expressed in this paper are strictly those of the author and do not necessarily state or reflect the views of *The Brattle Group*, Inc. or its clients.

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INTRODUCTION AND OVERVIEW

Broadband connectivity is becoming increasingly important to modern society—from facilitating economic activity to increasing the effectiveness of government. This connectivity is increasingly being provided over mobile wireless networks. To meet the growing demand for wireless broadband, access to additional radio spectrum frequencies will be essential. Such frequencies, particularly those below 3 GHz that are suitable for mobile communications, are a limited resource. Consequently, access to them is highly valuable.

Ensuring that spectrum rights are distributed efficiently—licensed to the users who can make the most productive use of them—is critical. In an unconstrained market where rights to access spectrum are freely traded, market forces would ensure that spectrum is put to its highest valued uses. In the current system of administratively allocated spectrum rights, market mechanisms cannot provide the incentives or avenues for radio spectrum to move from lower to higher valued uses. Therefore, care must be given in the allocation process to put spectrum to its highest valued uses. Getting this wrong has big costs, most importantly in lost consumer welfare.

This paper will focus on the 20 MHz AWS-3 band and the potential to pair it with either the 1690 MHz[1] or 1755 MHz band. The key question is which lower band pairing will create the most economic value? To answer this question, this paper first discusses the economic underpinnings of spectrum value. Spectrum is not inherently valuable; rather its value is derived from the value of spectrum-based services that can be provided. As a result, bands of spectrum that are more costly to deploy are worth less than bands that are less costly to deploy.

Any cost differences between pairing the AWS-3 band with 20 MHz in the 1755 MHz band versus pairing it with 20 MHz in the 1690 MHz band translate into value differences. This paper identifies three specific cost differences between the 1755 MHz and 1690 MHz bands and estimates their effect on spectrum value. First, increased network infrastructure costs lower future profits, causing the net present value to decline. Second, added costs of devices such as handsets and computer dongles lead to increased customer subsidies, again causing profits and spectrum value to be lower. Third, added risk of using a non-standardized band results in more heavily discounted—that is, lower present value—future expected profits.

The cumulative effects of these cost differences are substantial. The value of the AWS-3 band paired with the 1755 MHz band is approximately $12 billion. (Including the additional 5 MHz at 2175 MHz to 2180 MHz and using the entire 25 MHz of the 1755 MHz band would increase this value by about 25%.) A well structured FCC auction would be expected to realize this value in bids for access to the spectrum. Pairing the AWS-3 band with the 1690 MHz band would reduce expected receipts by $4.7 billion, to $7.3 billion. An asymmetric pairing with 1695 MHz – 1710 MHz would reduce receipts a further $0.9 billion, to $6.4 billion. Accounting for the exclusion zones associated with the 1695 MHz band, receipts would be reduced by an additional $1.1 billion, to $5.3 billion. Although a significant reduction in value, any of these pairings is preferred to allocating the AWS-3 band as unpaired. In that case, expected auction receipts would be only $3.6 billion.

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[1] Although the FCC has requested comments on pairing with the spectrum in the 1675 MHz – 1710 MHz band, this paper focuses on the 1690 MHz to 1710 MHz band for the 20 MHz allocation and the 1695 MHz to 1710 MHz band for the 15 MHz allocation. Given the band options between 1675 MHz and 1710 MHz, it would be most optimal—should this option be selected—that the pairing include the 20 MHz of spectrum adjacent to the existing AWS-1 1710 MHz band.

ECONOMICS OF SPECTRUM VALUE

Why is radio spectrum valuable? Unlike gold, radio spectrum is not inherently valuable. Rather its value derives from its use in producing services. The value today is simply the present value of the future profits that can be earned using the resource. As the profitability of providing spectrum-based services such as wireless broadband increases, for example because demand for those services increases, the value of the spectrum asset also increases. Likewise, if the future stream of profits from providing spectrum based services decreases, for example because the cost of providing those services increases, then the value of the spectrum asset decreases. In fact, different bands of spectrum have different values specifically because the profitability of the services that can be provided with those bands differ.

SPECTRUM VALUE IS DERIVED FROM THE VALUE OF SPECTRUM BASED SERVICES

Spectrum is not a store of value; rather, it is an input into the production of valued services. These spectrum-based services include mobile communications (such as cell phones and mobile broadband), fixed communications (such as broadcasting and wireless data links), and detection applications (such as radar). Provision of such services increases consumer welfare by providing valued services. Typically, consumers benefit more than what they pay for services—in the case of wireless services the excess benefit can be substantial.[2] The derived value of spectrum is based on the value it adds to these services.

For example, to provide mobile phone service, a service provider must first secure rights to use radio spectrum, make capital investments to build a network, and then commit to expenditures to operate, market, and deliver mobile phone service. Building a mobile phone network requires significant capital investments in such things as cell sites (renting or building towers, hanging radios, installing other communication and electrical equipment on site), back-haul capabilities, and network operations centers. To provide service an operator must market its service, operate its network, and provide customer support and billing services. Profit is what remains after revenue from customers is collected and all of the inputs into this process (construction costs, salesperson salaries, etc.) are paid. What a network operator can pay to secure the spectrum rights is determined by these profits. The operator cannot pay more than the value of those profits (or the operator would lose money on the venture). The operator is also unlikely to pay much less than this or a different operator (also able to make profits from deploying and operating a wireless network) would be willing to pay more than the first operator for access to the scarce spectrum rights.

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[2] Bazelon, Coleman. "The Need for Additional Spectrum for Wireless Broadband: The Economic Benefits and Costs of Reallocations." Sponsored by *Consumer Electronics Association*, 2009, p. 21.

The value of a given band of spectrum is limited by the profits that can be made with its use, which are, in turn, limited by the profits from alternative ways to provide the same service. For example, because a fixed microwave data link could be replaced with a fiber optic cable if the microwave data link becomes more expensive, the price of data transmission services via fixed microwave link will not rise above the price of those services when provisioned over a fiber optic link. The cost of the alternative limits how profitable the spectrum based service will be and, in turn, how much value is attributable to the spectrum resource.

For services that have no alternative to using spectrum, such as mobile phone service, the value of spectrum is limited by the incremental capital costs of increasing capacity on existing bands of spectrum. As the example above illustrates, capital investments in cell sites are required to use spectrum for mobile phone service. One alternative to investing in a given band of spectrum is to provide the same capacity with less spectrum (or greater capacity can be provided with the same amount of spectrum) by increasing capital investments to make cells smaller and increase the amount of frequency reuse.[3] Note that these capacity-increasing capital expenditures become progressively more expensive.[4] Additional spectrum is only economically viable if the cost is lower than that of expanding the existing capacity of spectrum through increasingly expensive capital investments.

SPECTRUM VALUE IS BASED ON THE ECONOMIC CONCEPT OF RENT

Things that are in relatively fixed supply (or have inelastic supply in the language of economists[5]) garner what economists call economic rent.[6] The iconic example of rent is the value of land; the concept applies equally well to radio spectrum.[7] Rent is payment based on scarcity. Land in Manhattan is scarce in the sense that there is high demand for it and limited supply. Similarly, attractive frequencies for mobile telephony are scarce—there is much demand for them and they are in limited supply. The amount of rent paid for an asset reflects its scarcity, which in turn reflects the added value created by a given asset over its alternative. The concept of economic rent applies equally to the sale of assets as it does to the lease of assets, which is the more common usage of the term "rent."

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[3] Another alternative is to upgrade to more spectrum efficient technologies. For a more complete discussion of this tradeoff between spectrum and capital investments, see "Mobile Broadband: The Benefits of Additional Spectrum." FCC Staff Technical Paper, October 2010: pp. 20 – 21. http://www.fcc.gov/Daily_Releases/Daily_Business/2010/db1021/DOC-302324A1.pdf

[4] As the coverage of cell sites get smaller, dividing the cell creates less incremental capacity, but the costs of smaller cells does not decrease nearly as fast and at some point may not decrease at all.

[5] In the current case, spectrum economists refer to the relatively fixed supply as a supply elasticity close to zero. Supply elasticity is measured as the ratio of the percentage change in supply of a resource, given a percentage change in its price. For example, if elasticity is equal to 1 a 10 percent increase in price implies a 10 percent increase in supply. An elasticity that is close to zero is said to be inelastic, since a 10 percent increase in price will result in a near zero percent increase in supply.

[6] Ricardo, David. *On the Principles of Political Economy and Taxation*, Chap. 2 "On Rent". 1821. Library of Economics and Liberty. 26 July 2010. <http://www.econlib.org/library/Ricardo/ricP.html>. See also Jevons, William Stanley. *The Theory of Political Economy*. 1888. Library of Economics and Liberty. 26 July 2010. <http://www.econlib.org/library/YPDBooks/Jevons/jvnPE.html>; Sowell, Thomas, *On Classical Economics*, Yale University Press, 2006: pp. 50 - 54; Blaug, Mark. *Economic theory in retrospect*. Cambridge University Press, 1997: pp. 75 – 84 and 112 – 114.

[7] Like land, the total amount of radio spectrum is fixed. Similar to land, some is under private control and some is publicly owned with public access rights. The discussion herein applies to licensed radio spectrum, analogous to privately owned land. Some analysts argue that spectrum should not be managed

The value of a spectrum license is captured by economic rent. To understand economic rent, generally it is helpful to differentiate between normal economic returns for a product, and the value added by some capital asset. In a competitive market normal economic returns cover the cost of capital investment (including interest payments and returns to equity holders) and production. This ensures it is worthwhile to stay in the market. Any return above these normal economic returns is economic profit. Economic profit occurs because the product has some added value, based on a scarce resource such as a capital asset, that is not a generic input into production. When economic profits are attributable to a capital asset, the portion of profit derived from using a particular capital asset is referred to as the rent of that asset.

Put differently, the economic rent of an asset is the added value, or net return to investment, of using that asset over the least efficient, or least desirable, alternative asset available. As the quality of assets diminishes incrementally relative to superior assets, the economic rent of the inferior assets also decreases until, in Ricardo's words "the capital last employed pays no rent."[8] Economic rent, therefore, represents the additional value a producer is willing to pay to use the characteristics and quality of an asset.[9] When the capital assets of production are fixed (inelastic), economic rent is the additional profit or value, above normal economic returns, from using a superior asset. For instance, this is the value of the microwave link over the cost of fiber optic cable. Alternatively, this is the value of deploying additional spectrum over the capital costs of increasing capacity by the same amount through cell splitting.

(as much) under a licensed regime, but rather should be unlicensed. This issue of licensed versus unlicensed access to radio spectrum is beyond the scope of the current paper; however, I have addressed it elsewhere. See, Bazelon, Coleman. "Licensed or Unlicensed: The Economic Considerations in Incremental Spectrum Allocations." *IEEE Communications Magazine*, March 2009: pp. 110-116. For a discussion of the difference between property regimes (licensed vs. unlicensed) and access regimes, see, Hazlett, Thomas W., and Coleman Bazelon. "Market Allocation of Radio Spectrum." Prepared for the *International Telecommunications Union Workshop on Market Mechanisms for Spectrum Management*. Geneva, Switzerland, January, 2007.

[8] Ricardo, David. *On the Principles of Political Economy and Taxation*, Chap. 2 "On Rent". 1821. Library of Economics and Liberty. 26 July 2010. <http://www.econlib.org/library/Ricardo/ricP.html>. Chapter 2. Paragraph 9.

[9] This concept is similar to opportunity cost, or the additional value of using an asset for one purpose over the next best alternative. Opportunity cost captures the concept of alternative uses for an asset. For instance, one might ask what is the opportunity cost of using a given set of frequencies for broadcasting versus for mobile broadband. (The answer to that question can be found in Bazelon, Coleman. "The Need for Additional Spectrum for Wireless Broadband: The Economic Benefits and Costs of Reallocations." Sponsored by *Consumer Electronics Association*, 2009.)

Since economic rent represents what a producer is willing to pay for the privilege of use, it is not theoretically captured by the producer, but extracted by (i.e., paid to) the asset owner.[10] When the producer must pay for the use of such a fixed capital asset, these economic profits are transferred from the user of the asset to the owner of the asset in the form of rental payments (or the equivalent, such as licensing fees.) For example, in the case of farming, there is no economic profit to farming over the long run (because farmers are in elastic supply and more farmers will enter the market if there is economic profit), but there may be to owning farmland.[11]

SPECTRUM VALUE IS THE PRESENT VALUE OF A STREAM OF FUTURE PROFITS

The "owner" of a band of spectrum could either extract the economic profits of using that band year-by-year, say through some sort of leasing arrangement[12] or, as when FCC licenses are auctioned, in a lump sum for the current value of the license rights over some predetermined number of years. To calculate the present value of the economic profits earned from the spectrum over time, the economic concept of net present value (NPV) is employed.

As with any capital investment, the net return of investing in a band of spectrum will be realized over time. The upfront capital investment is expected to result in a stream of net returns (revenue, minus cost), over the lifetime of the asset. The value of the investment and expected stream of profits depends critically on the timing of this stream of returns. The present value of any future payment is equal to the amount you would need to invest today to receive that future return. Given an interest rate of 5 percent, the present value of $105 next year is $100 today. Just as the value of $100 today is greater than the value of anticipating receiving $100 next year, the value of a capital investment project that does not begin to yield a stream of revenue until next year will be lower than a similar project that yields profits immediately. This concept of the time value of money is captured by the NPV.

The NPV of a capital investment represents the cash value today of the expected stream of net returns (revenues minus costs) that an investment is expected to yield over its lifetime. The NPV accounts for the interest that investment would have otherwise accrued over the investment period. The present value of any investment is equal to the sum of the present value of each annual net return or cash flow (CF), discounted by the rate of return for that year[13]:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+R_t)^t}$$

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[10] In the case of farmland, the landlord captures this value in rent. If a tenant is not willing to pay, the landlord can find another who is willing to pay for the added productive value of the specific land.

[11] The owner and user of an asset may be the same entity (or farmer), but the income earned as an owner is distinguished from the income earned as a user.

[12] For example, spectrum lease agreements typically require payments of between 10% and 20% of gross revenues from using the spectrum. Such payments are a proxy for the economic profits earned from using the band of spectrum.

[13] Damodaran, Aswath. *Investment Valuation 2nd Edition*. New York, NY: John Wiley and Sons, 2001.

Investments that have higher levels of risk have higher expected rates of return (R) or, equivalently, higher discount rates. As a result, the NPV of each anticipated cash flow is more heavily discounted today. Consider two equal streams of profit that have different levels of risk, but the same expected cash flow. The less risky investment with a lower interest rate is more valuable today. It is important to note that the riskiness of an investment that leads to a higher discount rate is not simply the uncertainty about expected returns; rather, it is how those returns are correlated to the returns of a well balanced portfolio of investments.[14] If the chance of being above or below the expected value of an investment is unrelated to other investments, then the financial markets will treat the investments as riskless. (This is because the risk can be diversified away.) When evaluating different streams of expected profits from using spectrum, the discount rates used would differ only if one of the investment's returns were more correlated to overall economic performance than the other investment's returns.

IMPLICATIONS FOR SPECTRUM VALUE: DIFFERENCES IN SPECTRUM VALUE ARE BASED ON DIFFERENCES IN SPECTRUM QUALITY

Differences in the value of bands of spectrum are driven by differences in the added value of using them, which broadly reflects differences in the quality of spectrum. The quality of a band of spectrum is determined by at least three factors: the physical characteristics of the spectrum, including frequency wavelengths and potential pairings; the existence of band compatible technology for both infrastructure and devices; and encumbrances to use, such as incumbent users and service restrictions placed on licenses. Each of these factors of quality impact the value of a band by affecting the revenues, costs, and uncertainties of using the spectrum. The relative quality of a spectrum band varies by use (i.e., broadcast vs. wireless services), region (i.e., rural vs. urban) and the availability of technology and infrastructure for specific uses of the band.

Physical characteristics. The wavelength of a frequency is a key determinant of its best uses. Frequencies above about 3 GHz are not currently as conducive to mobile communications. Lower frequencies require less energy to transmit signals over a given distance and are more capable of penetrating walls and buildings. Even for frequencies under 3 GHz, higher frequency spectrum within that range requires more cells and higher power levels vis-à-vis lower frequency spectrum for the same level of coverage, resulting in either higher costs for the same level of service, or lower quality service, less capacity and diminished revenue. The extent to which higher frequencies are less valuable depends on the intended use. Long signal range is more important in rural areas. In urban areas, the high density of users requires more cells, making this issue less relevant.

Given the current state of technology, pairing spectrum also tends to make the spectrum more valuable. For spectrum services that require two-way communications, pairing bands allows them to be used more efficiently by diminishing interference from incompatible adjacent operations.[15] As discussed in more detail below, this greater efficiency is seen in relative spectrum prices.

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[14] Technically, this is known as the beta of an investment and measures the covariance of the returns to an investment with the returns to a well balanced portfolio of investments. See, Damodaran, Aswath. *Investment Valuation 2nd Edition*. New York: John Wiley and Sons, 2001.

Existence of Applicable Technology. The ecosystem of a band of spectrum—both in technology and in users and services—can greatly affect its value. Any new wireless technology requires network equipment and devices. Spectrum users must find suppliers for both. The compatibility of existing infrastructure, hardware and software with the radio frequencies within a band is a critical determinant of its value because research and development is costly, time consuming and risky.[16] Often a more mature band already has equipment available to use the spectrum. This is considerably less costly to use immediately or upgrade. It may also have a more readily accessible user base, potentially increasing expected revenues. A larger amount of bandwidth in a band also tends to create more demand for equipment. Economies of scale and scope decrease the cost and burden of fixed research and development costs for individual users of the band because they can take advantage of conventional hardware and software. Mature bands that are internationally harmonized tend to have larger user bases, and thus, lower costs, and higher certainty of the availability in the latest technology.

Encumbrances. Restrictions on licensed use, the existence of incumbent users, or interfering neighbors decreases the value of spectrum because it potentially restricts revenues, increases costs and raises uncertainties about profit timing. Many bands have incumbent users that must be migrated to different radio frequencies before the spectrum is fully available. Exactly when this will occur adds even more uncertainty to a project. Limited use of a band in the interim may be a possibility, but it will likely diminish revenues. Uncertainty in spectrum availability and profit timing can diminish a band's expected value.

Licensing restrictions may reduce revenues by limiting the capacity or the types of services for a given spectrum band. This can clearly be seen in the television bands where licensees are restricted to broadcasting and cannot repurpose the spectrum themselves. The spectrum allocated to television broadcasting would be worth about $62 billion if completely unencumbered and reallocated to broadband services, but is only worth about $12 billion when used in broadcasting.[17] This difference of $50 billion represents the diminished value of those frequencies as a result of license restrictions, such as not being allowed to lease spectrum for any use except broadcasting.

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[15] See discussions on AWS-3 band interference in "Notice of Proposed Rulemaking in the Matter of Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band." FCC Docket 07-164 adopted September 7, 2007, released September 19, 2007; and in "AWS-3 To AWS-1 Interference Laboratory Test Report." *T-Mobile USA, Inc.*, downloaded August 18, 2010 from <http://fjallfoss.fcc.gov/ecfs/document/view?id=6520035719>. To avoid interference, the FCC could set power restrictions on the single band, which would decrease its capacity, see, "Advanced Wireless Service Interference Tests Results and Analysis." *FCC*, October 10, 2008, downloaded August 18, 2010 from <http://fjallfoss.fcc.gov/edocs_public/attachmatch/DA-08-2245A2.pdf>.

[16] See, Varrall, Geoff. "RF Cost Economics for Handsets." *RTT* white paper, May 2007 <www.rttonline.com/research/RFCostEconomicsForHandsets-study.pdf> for further discussion.

[17] See, Bazelon, Coleman. "The Need for Additional Spectrum for Wireless Broadband: The Economic Benefits and Costs of Reallocations." Sponsored by *Consumer Electronics Association*, 2009. This valuation assumes no restrictions or encumbrances on the reallocated TV frequencies when they are sold.

Having to tolerate interference from—or to prevent interference into—users in neighboring bands also reduces the usefulness of a band and, consequently, its value. Operating in an environment with interference can require higher power levels or other adjustments that decrease the capacity of a band of spectrum. Less capacity, or otherwise doing less with the same inputs, reduces the value of spectrum.

PAIRING AWS-3 BAND

The FCC's National Broadband Plan (NBP) raised the issue of pairing the AWS-3 band. Specifically, the NBP asked that the National Telecommunications and Information Administration (NTIA) explore the possibility of pairing the AWS-3 band with spectrum in the 1755 MHz – 1850 MHz band. NTIA responded by proposing consideration of the 1675 MHz – 1710 MHz band.[18] Because both of these bands are used by the federal government the issue will be resolved by the FCC working in conjunction with the NTIA and relevant federal agencies.

An NTIA report dated October 2010 recommends reallocating 115 MHz of spectrum currently devoted to Federal agencies to wireless broadband over the next five years. Their proposal included making the 15 MHz of spectrum in the 1695 MHz – 1710 MHz band available for pairing with the AWS-3, subject to exclusion zones covering 12% of the US population.[19] This 15 MHz was the only spectrum below 3 GHz that NTIA made a recommendation on. Although it was up for fast track consideration, NTIA said it was unable to comment on the 1755 MHz – 1780 MHz spectrum at that time.[20] More recently, the NTIA identified the 1755 MHz – 1780 MHz band as the next band they will evaluate for reallocation.[21]

VALUE OF PAIRING

Traditionally, two-way communications, such as mobile phone services, have been provided over paired bands of spectrum. With a paired band, a portion of the frequencies (usually half) are used to transmit from the base station to the mobile device and the remainder of the band is used for mobile to base station transmissions. The two bands in the pair are separated from each other so the up-stream and down-stream transmissions are not adjacent in order to prevent interference with each other. Most currently deployed mobile communications systems use symmetrically paired spectrum.

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[18] "Connected America: The National Broadband Plan." *FCC*: pp. 86 – 87. (Referred to hereafter as "*NBP*.") See also, "Spectrum Policy in the Age of Broadband Issues for Congress." *CRS*, June 21, 2010; FCC Public Notice, DA 10-1035, released June 4, 2010.

[19] The exclusion zones included the major markets of Washington DC, San Francisco, Miami, and substantial portions of Los Angeles. See Table 1. "An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands." *NTIA*, October 2010. (Referred to hereafter as "*NTIA Report*.") According to the report, "NTIA recommends that 15 megahertz of the 1675-1710 MHz (specifically 1695-1710 MHz) spectrum could be made available for wireless broadband use within five years" (p. v). NTIA reviewed this band as a possible pairing with the 2155-2180 MHz band (p. iv).

[20] See *NTIA Report*.

[21] "NTIA Takes Next Step in 500 MHz Wireless Broadband Initiative, Agency to Conduct a Detailed Analysis of the 1755-1850 MHz Band," available at: http://www.ntia.doc.gov/press/2011/500mhzstatement_02012011.html.

Licensed unpaired spectrum has traditionally been used for broadcasting—the one-way transmission of radio signals.[22] More recently, newer technologies allow for the use of unpaired spectrum for two-way communications. WiMax and future releases of LTE can use unpaired spectrum either for stand alone two-way communications systems or for one-way communications in conjunction with paired bands.[23] In most relevant cases, the performance of unpaired spectrum is not as high as paired spectrum.[24]

The difference in profitability of using paired versus unpaired spectrum is reflected in the value of the two types of spectrum. This was very clearly seen in the 700 MHz auction in 2008.[25] In that auction four bands of very similar 700 MHz spectrum were auctioned. The Lower A and B blocks had 12 MHz of paired spectrum with 6 MHz bands each for uplink and downlink (A block: 698-704/728-734 MHz; B block: 704-710/734-740 MHz). The Upper C block totaled 22 MHz of paired spectrum with 11 MHz bands each for uplink and downlink (Upper C block: 746-757/776-787 MHz). Only one unpaired band, the Lower E block which was 6 MHz (E block: 722-728 MHz) was sold at the same time. The average price of the A, B & C blocks was $1.36/MHz-Pop and the average price of the E Block was $0.74/MHz-Pop, a discount of 46% for the unpaired band.[26] Furthermore, as noted in the National Broadband Plan, pairing the AWS-3 band with another band would likely increase its value.[27]

The difference in value of paired versus unpaired bands has likely changed somewhat in the intervening two years. The existence of technology to use unpaired spectrum for two-way communications—notably WiMax—was known at the time of the 700 MHz auction. In the intervening two years, the technology has become more developed, and a modest revision of expectations from early 2008 of using unpaired spectrum for two-way communications may be in order. This is illustrated by Qualcomm's recent sale of its portion of the E Block and the entire Lower 700 MHz Band D Block (also an unpaired 6 MHz band) to AT&T. The sale represented an increase in value over the 700 MHz E Block of 5.5%.[28] However, given that the value of the 700 MHz paired spectrum has declined by 5%[29] over the same time period the implied discount for unpaired spectrum compared to paired spectrum would be 40%.[30] I will use this updated discount throughout the remainder of this analysis.

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[22] Radar also uses unpaired bands, but radar is not a commercially relevant application and not included in the rest of the analysis. Unlicensed bands, such as those used for WiFi are also unpaired.

[23] "Spectrum Analysis for Future LTE Deployments," Motorola White Paper downloaded on September 12, 2010 from: <http://www.motorola.com/staticfiles/Business/Solutions/Industry%20Solutions/Service%20Providers/Wireless%20Operators/LTE/_Document/Static%20Files/LTE_Spectrum_Analysis_White_Paper_New.pdf>. For a discussion of technology for unpaired spectrum, including WiMAX and LTE, see Ramsay, Maisie. "TD-LTE: A Threat to WiMAX?." *Wireless Week*. July 15, 2010, downloaded January 17, 2011 from <http://www.wirelessweek.com/Articles/2010/07/Networks-TD-LTE-A-Threat-To-WiMAX/>.

[24] "Spectrum Analysis for Future LTE Deployments." *Motorola*, downloaded September 12, 2010 from <http://www.motorola.com/staticfiles/Business/Solutions/Industry%20Solutions/Service%20Providers/Wireless%20Operators/LTE/_Document/Static%20Files/LTE_Spectrum_Analysis_White_Paper_New.pdf>

[25] A discount for unpaired spectrum was also seen in the recent 2.6 GHz auctions in Germany. See slide 12, Dr. Ulrich Stumpf and Dr. Lorenz Nett. "The German auction design – Conclusions for Europe." *European Workshop on Spectrum Auctions* at the Federal Network Agency. October 29, 2010, downloaded January 17, 2011 from <http://www.bundesnetzagentur.de/cae/servlet/contentblob/161682/publicationFile/8987/3_WIKTheGermanAuctionDesign.pdf>.

[26] Bazelon, Coleman. "Too Many Goals: Problems with the 700 MHz Auction." *Information Economics and Policy*, April 8, 2009.

[27] "Connected America: The National Broadband Plan" (NBP) *FCC*: pp. 86 – 87. See also, "Spectrum Policy in the Age of Broadband Issues for Congress." *CRS*, June 21, 2010; FCC Public Notice, DA 10-1035, released June 4, 2010.

TWO POTENTIAL BANDS

The two potential bands to pair with the AWS-3 band are the 1690 MHz band and the 1755 MHz band. The NBP proposed that NTIA consider benefits of pairing the AWS-3 with the 1755 MHz – 1850 MHz band. NTIA decided to assess 1675 MHz – 1710 MHz band as a possible pairing. In turn, FCC requested comments on a 1675 MHz – 1710 MHz pairing.[31] The spectrum between the two bands, at 1710 MHz – 1755 MHz, is already allocated as the AWS-1 band.

1755 MHz – 1780 MHz band

This band is currently allocated by the federal government and used for fixed microwave communication and video surveillance systems that had been migrated from the 1710 MHz –

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[28] In December 2010, AT&T agreed to acquire 6 MHz of Qualcomm's nationwide D Block spectrum and another 6 MHz of E Block spectrum in 5 metropolitan markets for $1.925 billion. (See "AT&T Agrees to Acquire Wireless Spectrum from Qualcomm." AT&T press release. December 20, 2010.) Qualcomm's E Block licenses, which was comprised of 6 MHz of unpaired spectrum in 5 metropolitan markets, represented 44% of the nationwide E Block value in Auction 73. Assuming that the value of the 6 MHz of nationwide D Block spectrum that AT&T acquired is equal to the value of the E Block nationwide, this deal represents 144% of the value of spectrum licensed in the E Block Auction 73 (i.e., 100% of the 6 MHz D block nationwide, plus 44% of the value for 6 MHz of E block in 5 metropolitan areas). At the time of the Qualcomm deal, the E Block alone would be worth $1.337 billion ($1.925billion/1.44). This represents a 5.5% increase in value over the $1.267 billion realized during Auction 73. (See Auction 73 results downloaded from FCC Auctions at http://wireless.fcc.gov/auctions).

[29] SpecEx Spectrum Index from Spectrum Bridge® values of 300 on March 18, 2008 and 285 on December 20, 2010 retrieved January and April from <http://spectrumbridge.com/products-services/specex/index.aspx>. SpecEx Spectrum Index tracks changes in spectrum value reasonably well. For instance, the change in SpecEx Index values closely tracked the change in AWS spectrum value based on NextWave's AWS spectrum sale to T-Mobile in July 2008. The NextWave sale reflected a 91% increase in AWS spectrum value, whereas, the SpecEx Index in the same period indicated an 86% increase in spectrum value. See Auction 66 results from <www.fcc.gov/auctions> and NextWave Wireless Inc. 8-K filed July 23, 2008 for details.

[30] The value of unpaired spectrum increased by 5.5% from $0.74 MHz-Pop to $0.78 MHz-Pop. Over the same period, the value of paired 700 MHz spectrum decreased by 5% to $1.29 MHz-Pop. Unpaired spectrum is now 60% of the value of paired spectrum, representing a 40% discount for unpaired (over paired) spectrum.

[31] FCC Public Notice, DA 10-1035, released June 4, 2010.

1755 MHz to clear AWS-1 band. The band also holds military mobile communication equipment, as well as satellite uplinks for telemetry, tracking and control of satellites.[32]

This spectrum is already internationally harmonized for commercial mobile use. In fact, some countries already allocate spectrum 1710 MHz – 1780 MHz to such uses.[33] As a result, there are currently devices available that will work with this band, which create international "synergies" and reduce uncertainty associated with developing handsets and software.[34] Additionally, the duplex spacing (i.e., the spectrum "distance" between the top of the upstream and downstream links) would be identical to the AWS-1 spectrum. This would also potentially cut down on the cost of developing compatible devices.[35] This spectrum is well suited to commercial mobile services, and was recognized by the NBP as a good candidate for pairing with the AWS-3 band.

Although only 20 MHz of the 25 MHz in the 1755 MHz – 1780 MHz band is needed to pair with the AWS-3 band, the 5 MHz just above the AWS-3 band at 2175 MHz to 2180 MHz could be added to the allocation (for an addition of 10 MHz in total) to make a new allocation with a total of 50 MHz of paired spectrum. Such an allocation would be 25% larger than the 40 MHz paired allocation considered in this analysis. Similarly, its value would be approximately 25% greater.

1690 MHz – 1710 MHz band[36]

The 1690 MHz – 1710 MHz block is allocated to the federal government and currently used primarily by federal agencies for weather, research and defense.[37] Agencies using this spectrum include the National Oceanic and Atmospheric Administration (NOAA) and other research groups that transmit weather related information through NOAA satellites. These groups use the band as the downlink from weather satellites and weather balloons.[38]

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[32] See "Federal Spectrum Use Summary", *NTIA*, June 21, 2010, downloaded on September 12, 2010 from <http://www.ntia.doc.gov/osmhome/spectrumreform/Spectrum%20Use%20Summary%20Master-06%2021%2010.pdf>.

[33] See *NBP*, p.86. See also, Table 1 of Varrall, Geoff. "RF Cost Economics for Handsets." *RTT* white paper, May 2007 <www.rttonline.com/research/RFCostEconomicsForHandsets-study.pdf>. See also, "In the Matter of Office of Engineering and Technology Requests Information on Use of 1675 – 1710 MHz Band." *Comments of CTIA – The Wireless Association* before the FCC, ET Docket No. 10-123, June 28, 2010.

[34] See *NBP*, p. 86.

[35] See, Varrall, Geoff. "RF Cost Economics for Handsets." *RTT* white paper, May 2007, available at <www.rttonline.com/research/RFCostEconomicsForHandsets-study.pdf> for discussion of how standard spectrum allocations lower the cost of developing handsets.

[36] This paper assesses the value of the 20 MHz of spectrum from 1690 MHz to 1710 MHz. Any other 20 MHz block of the frequencies between 1675 MHz and 1710 MHz would have lower values than those estimated here.

[37] FCC Public Notice, DA 10-1035, released June 4, 2010. For further detail see, "Federal Spectrum Use Summary, 30 MHz – 3000 GHz." *NTIA Office of Spectrum Management*, June 21, 2010.

[38] *Ibid.*

The 1690 MHz – 1710 MHz is not internationally harmonized for commercial wireless use.[39] In addition, the duplex spacing created by potentially pairing with AWS-3—465 MHz—is wider than any other major allocation used and does not conform with the duplex spacing of the adjacent AWS-1 band. This would require developing new receivers and extending existing radios to accommodate a wider band of spectrum. An asymmetric pairing of the 20 MHz of the AWS-3 band with the 15 MHz of the 1695 MHz to 1710 MHz band proposed by NTIA will be worth less than a symmetric pairing because it has less capacity. This issue will be discussed further below.

Sources of Cost Differences between the Two Bands

Regardless of the pairing, there are costs associated with building infrastructure to use the AWS-3 band for wireless services. Either pairing would require new base station transmission equipment for the new spectrum including antennas and tower-top amplifiers to reach the upper end of the 2175 MHz spectrum. There are, however, several cost differences that could materially affect the value of the spectrum.

Equipment Harmonization. Acquiring equipment for the non-harmonized 1690 MHz band will likely take additional time and require higher consumer costs. Economies of scale already exist for a band that is internationally harmonized for commercial use, such as the 1755 MHz band. Specifically, there are manufacturers that already produce compatible equipment for both the network and for consumers for the 1755 MHz band. By contrast, the 1690 MHz band will likely require the development of new equipment. Many manufacturers are reluctant to develop equipment for a non-harmonized band because the demand is inherently limited. It is likely that equipment will be both more expensive, take longer to develop, and have fewer features.

Band Clearing Costs. The costs of clearing a band can affect its value. If operators must incur additional costs to clear a band of spectrum—either through direct payments or increased regulatory activity—profits and spectrum value are reduced commensurately. Costs from delay of clearing incumbents can also reduce spectrum value if it delays the timing of realizing profits. This cost from delay can still be a concern even if the relocation costs are paid from a government fund. To the extent clearing the 1690 MHz band is more expensive, takes longer, or is more uncertain than clearing the 1755 MHz band, then, other things being equal, the present value of profits derived from that band would be lower.

Spectrum Sharing/Exclusion Zones. When bands of spectrum have incumbent users that are prohibitively expensive to relocate, portions of the band may be put to multiple uses through the various sharing techniques. In such cases, spectrum sharing strategies can have the advantage of making otherwise unavailable spectrum usable, but that value is diminished compared to unencumbered spectrum. One particularly blunt spectrum sharing strategy is to designate exclusion zones around incumbent users that are not going to be reallocated. This is the approach proposed by the NTIA with respect to the 1695 MHz – 1710 MHz band.[40] The areas proposed for the exclusion zones represent 12% of the U.S. population, but 17% of the value weighted population.[41] See Table 1.

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[39] "In the Matter of Office of Engineering and Technology Requests Information on Use of 1675 – 1710 MHz Band." *Comments of CTIA – The Wireless Association* before the FCC. ET Docket No. 10-123, June 28, 2010.

Table 1
Penalty on Spectrum Value Based on Exclusion Zones

		Population		
		Excluded Zones [1]	Total US [2]	Percent of Total [3]
Population	[A]	34,551,579	285,620,445	12%
Value Weighted Population	[B]	48,404,502	285,615,408	17%

Source and Notes:
[A] [1]: Population for excluded zones calculated by The Brattle Group through GIS. Excluded zones based on: U.S. Department of Commerice. "An Assessment of the Near-Term Viability of Accomodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 43980-4400 MHz Bands." October 2010, p.5-2.
[A] [2] : www.fcc.gov, Auction 66 results.
[B] [1] : Excluded population weighted by the relative value of CMA markets from Auction 66.
[B] [2] : Total population weighted by the relative value of CMA markets from Auction 66.
[3] : [1] / [2].

ILLUSTRATIVE IMPACTS

AWS-3: 1755 MHz VALUATION

In a well-functioning market, buyers have the incentive to accurately reveal and pay up to their true value for an asset. Under these circumstances, the value of a capital asset is best reflected by the price users are willing to pay for it. For spectrum licenses, this market value is captured either by the sale price in a well-structured auction or the contracted price in a private license transfer, provided a liquid market exists. Since the FCC has not yet issued licenses for the AWS-3 band, historical pricing information is not available. In the absence of direct AWS-3 pricing, the best alternative is to compare its value to that of other existing spectrum licenses with known value, and adjust for factors that are likely to impact the relative value between the two bands.

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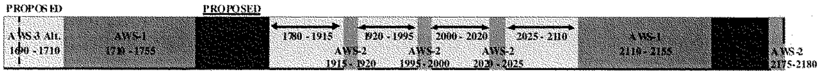
[40] See *NTIA Report*.

[41] This report does not analyze any potential exclusion zones for the 1755 MHz band.

Based on its quality and characteristics, the AWS-1 band is the most comparable band to the AWS-3 band. Assuming AWS-3 is paired with 20 MHz of spectrum in the 1755 MHz – 1780 MHz band, the two share a number of qualities that typically impact spectrum value. First, both the uplink and downlink bands of AWS-1 and AWS-3 would be adjacent (see Figure 1). As a result, their spectrum wavelengths have similar signal characteristics and equal duplex spacing between pairs. In fact, if AWS-3 was paired with 1755 MHz – 1780 MHz, then AWS-1 and AWS-3 would be similarly harmonized. Devices designed for the AWS-1 band then could be easily modified for the paired AWS-3 spectrum.[42] These bands also share many of the same fixed microwave federal incumbents.[43] Relocation challenges for the two bands are so similar that the FCC requires that both AWS-1 and future AWS-3 license holders share the cost of clearing encumbrances.[44] From the bidder's perspective the 1755 MHz clearing costs are similar to AWS-1 clearing costs because the direct costs are covered by the federal government, possibly out of auction revenues.[45] Since the AWS-1 auction in September 2006 was competitive, its results are likely to reflect AWS spectrum value.[46]

Figure 1. AWS Bands



Assuming the 20 MHz of spectrum in the 1755 MHz – 1780 MHz band is paired with the AWS-3 band, the combined 40 MHz of spectrum would be worth nearly $12 billion. Table 2 outlines this calculation. The average auction price of the AWS-1 spectrum in 2006 was $0.54/MHz-Pop. This price needs to be adjusted to account for the change in spectrum value over time. According to the SpecEx Spectrum Index, the value of spectrum increased 94% between September 18, 2006 and April 7, 2011.[47] Updating the average price of AWS-1 spectrum by this percentage provides a current price of $1.05/MHz-pop.[48] This price implies that the total value for the 40 MHz of spectrum is nearly $12 billion assuming a U.S. population of 286 million.[49]

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[42] "In the Matter of Office of Engineering and Technology Requests Information on Use of 1675 – 1710 MHz Band." *Comments of CTIA – The Wireless Association* before the FCC, ET Docket No. 10-123, June 28, 2010.

[43] *Ibid.*, p.6.

[44] "Ninth Report and Order." FCC 06-45. Some of the incumbents to the AWS-1 spectrum also use some AWS-3 spectrum. Under the rules set out in the Ninth Report and Order, once AWS-3 licenses are assigned, the AWS-3 license holders will have to compensate AWS-1 license holders who have already cleared incumbents from the AWS-3 in their effort to clear incumbents from the AWS-1 spectrum.

[45] Should the value of the spectrum at auction not be sufficient to cover the clearing costs, then the reallocation should not take place.

[46] Bulow, Jeremy, Jonathan Levine and Paul Milgram. "Winning Play in Spectrum Auctions." *NBER* Working Paper No. 14765, March 2009.

[47] SpecEx Spectrum Index from Spectrum Bridge® values of 156 on September 18, 2006 and 303 on April 7, 2011 retrieved April 2011 from <http://spectrumbridge.com/products-services/specex/index.aspx>.

[48] In this analysis I do not take account of the impact of the increased amount of spectrum available for mobile broadband services on the price of spectrum. The current proposal only increases total licensed spectrum

Table 2
Implied AWS-3 Spectrum Value from AWS-1 Auction Results

		AWS-1 Auction Value 9/18/2006 *[1]*	Current Value 4/7/2011 *[2]*
Spectrum Index Value			
SpecEx	[A]	156	303
SpecEx Percentage Change	[B] %		94%
Base Population	[C]	285,620,445	285,620,445
Spectrum Band Size	[D] MHz	90	40
AWS Value			
AWS-1 Total Value	[E] $	$13,879,110,200	
AWS Average Price	[F] $/MHz-Pop	$0.54	$1.05
Projected AWS-3 Paired with 1755 MHz Value	[G] $		**$11,981,112,224**
Unpaired Spectrum Value as a Percent of Paired Spectrum	[H] %		60%
Updated AWS Average Price for Unpaired Spectrum	[I] $/MHz-Pop		$0.63
Unpaired Spectrum Band Size	[J] MHz		20
Projected AWS-3 Unpaired Value	[K] $		**$3,619,835,261**

Source and Notes:
[A]: SpecEx Spectrum Index values downloaded from http://spectrumbridge.com/products-services/specex/index.aspx (accessed 4/7/2011).
[B]: ([A][2]-[A][1])/[A][1].
[C]: FCC population estimates based on Census 2000 data aggregated by basic trading area (BTA).
[D][1], [E]: Auction 66 results downloaded from FCC Auctions at http://wireless.fcc.gov/auctions.
[D][2]: Based on FCC proposal to pair the AWS-3 2155 MHz - 2175 MHz band with 20 MHz of spectrum between 1755 MHz - 1780 MHz.
[F][1]: [E][1]/([C][1]*[D][1]). [F][[2]: [F][1]*(1+[B][2])
[G]: [F][2]*[D][2]*[C][2].
[H]: The average price from the A, B and C block of the 700 MHz auction was $1.36/MHz-pop. The average price for the E block was $0.74 MHz-pop, 54% of the average price for the three paired licenses. A recent AT&T Qualcomm sales of the E-block spectrum suggests that the value of unpaired spectrum has increased to $0.63 MHz-pop.
[I]: [F][2]*[H][2].
[J]: Based on scenario in which the AWS-3 2155 MHz - 2175 MHz remains unpaired.
[K]: [C][2]*[I][2]*[J][2].

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by a few percentage points, making its impact on the spectrum price level minimal. For a fuller explanation of how to take account of this effect, see, Coleman Bazelon "The Need for Additional Spectrum for Wireless Broadband: The Economic Benefits and Costs of Reallocations." Sponsored by *Consumer Electronics Association*, 2009.

[49] For consistency of estimates and calculations, I use the Census 2000 population values used by the FCC.

AWS-3 UNPAIRED VALUATION

By contrast, assuming that the AWS-3 band remains unpaired, the expected value for the 20 MHz of spectrum in the 2155 – 2175 MHz band is about $3.6 billion. To find a discount for unpaired spectrum, I use the observed discount from the 700 MHz auction. As noted above, in the FCC's auction of 700 MHz spectrum in 2008, the average price for unpaired spectrum was 54% of the price for paired spectrum, which translates to a 46% discount.[50] The recent AT&T acquisition of unpaired 700 MHz licenses from Qualcomm updates this relation of unpaired to paired spectrum value to 60%.[51] If the updated average price for paired spectrum is $1.05/MHz-pop, this implies that the average price for unpaired spectrum is $0.63/MHz-pop. The expected value for all 20 MHz of AWS-3 spectrum nationwide would be just over $3.6 billion.

ESTIMATED DIFFERENCE FOR PAIRING WITH 1690 MHZ VS 1755 MHZ SPECTRUM

Pairing the AWS-3 with the 1690 MHz – 1710 MHz spectrum band will incrementally decrease its value through increased costs and uncertainty regarding equipment, thereby diminishing cash flow, future profits, and present value. The three cost shifts examined here are the expected increase in costs of devices and network equipment, as well as the added risks to expected future cash flows from developing the band. There may be additional costs to pairing AWS-3 with the 1690 MHz band not addressed here; to the extent additional costs are identified, they would flow through to reduce profits and lower net present value in ways similar to those described here.

The effects of increased costs and uncertainty are estimated through a generalized cash flow model. The essential feature of the model is an initial period of negative cash flows, followed by growing profits. To simplify the calculations, I assume that once the cumulative net present value of cash flows is zero, the model is in equilibrium. This is equivalent to a number of years of zero profits (the period over which the cumulative net present value of cash flows is zero) followed by a steadily growing stream of profits. This assumption allows me to model various expenses, such as amortized capital expenses and consumer equipment subsidies, as a fixed share of revenues, thus significantly simplifying the calculations.

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[50] Based on the price difference between the E Block and the A, B and C blocks. See <www.fcc.gov/auctions> for details.

[51] This value may only represent an upper bound of the unpaired-to-paired ratio because this sale from Qualcomm to AT&T coincided with a commitment by Qualcomm to build chipsets to use the band. See, "Qualcomm Announces Agreement for Sale of 700 MHz Spectrum Licenses." December 20, 2010 available at <http://www.qualcomm.com/news/releases/2010/12/20/qualcomm-announces-agreement-sale-700-mhz-spectrum-licenses> for Qualcomm's integration of carrier aggregation technology into its chipset roadmap for use in unpaired spectrum bands. AT&T plans to use this technology once compatible equipment is developed, see, "AT&T Agrees to Acquire Wireless Spectrum from Qualcomm." December 20, 2010 available at <http://www.qualcomm.com/news/releases/2010/ 12/20/att-agrees-acquire-wireless-spectrum-qualcomm>. Furthermore, because of its existing 700 MHz license holdings, AT&T was uniquely positioned to most efficiently use Qualcomm's spectrum.

As discussed above, one concern with the 1690 MHz – 1710 MHz band is the requirement for non-standard customer devices, such as handsets and computer dongles. Higher research and development costs, and lower demand for a non-standard device implies increased cost per device. For service providers, higher device costs are reflected on their balance sheet as increased cost of equipment, including additional device subsidies, rebates and customer concessions. The expected increase in device costs associated with a pairing with the 1690 MHz band are conservatively estimated to be about $5 per device.[52] This added cost can be modeled as an increase in equipment subsidies. A $5 increase in equipment subsidies represents about a 3% increase in such subsidies. As Table 3 illustrates, assuming equipment costs are 18 percent of revenue for the 1755 MHz band, a 3% increase in device costs implies that equipment costs would be 18.5% of revenue for the 1690 MHz band. Such increased cost further results in a 2.2% discount to the present value of cash flow. Based on the device penalty alone, the present value of cash flow for the 1690 MHz band is 2.2% lower than the present value of cash flow for the 1755 MHz pairing. If the value of the 1755 MHz pairing is almost $12 billion, this translates to a decrease of $264 million.

A second concern with the 1690 MHz band pairing is the increased network equipment costs. Pairing with the 1690 MHz band will require additional or modified infrastructure. For instance, existing radios will have to be upgraded to extend beyond the existing wavelengths or new radios will have to be developed. An increased capital cost of 10%[53] increases the amortized capital costs from 12% of revenues to 13.2% of revenues. Increased capital costs also increases operating costs, or cost of service. The cost of service increases 1.5 percentage points, from 15% to 16.5%. Combined, these costs result in a 10.8% decrease in the present value of cash flows. Based on the expected increase in network equipment costs alone, the present value of cash flow for the 1690 MHz band is 10.8% lower than the present value of cash flow for the 1755 MHz pairing or about $1.296 billion.

The cumulative effect of both the expected higher customer device and network equipment costs is a reduction in cash flows of about 13%. Such a reduction in profits would be expected to reduce the value of the band by about $1.56 billion.

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[52] Based on conversations with industry engineers.

[53] Discussions with industry engineers indicated these additional costs could be in the range of $1 billion. 10% increase in capital costs as a percentage of revenue is a rough approximation of the impact of $1 billion in added costs to a 40 MHz mobile broadband network.

Table 3
AWS-3 Band Value
Cash Flow for 1690 MHz Pairing as Percent of 1755 MHz Pairing

Basic Cash Flow Assumptions (For 1755 MHz)		**Factor**
Cost, amortized capital (% of revenue)	[A]	12.0%
Cost, service (% of revenue)	[B]	15.0%
Cost, equipment (% of revenue)	[C]	18.0%
Cost, SGA (% of revenue)	[D]	30.0%
Cash Flow (% of revenue)	[E]	25.0%
Penalties		
Capital Cost Increase	[F]	10.0%
Device Penalty	[G]	3.0%
Updated Costs for 1690 MHz - 1710 MHz Band		
Cost, amortized capital (% of revenue)	[H]	13.2%
Cost, service (% of revenue)	[I]	16.5%
Cost, equipment (% of revenue)	[J]	18.5%
Cost, SGA (% of revenue)	[K]	30.0%
Implied Cash Flow for 1690 MHz - 1710 MHz Band		
Cash Flow Including Device Penalty (% of revenue)	[L]	24.5%
Cash Flow Including Device Penalty (% of 1755 MHz Cash Flow)	[M]	97.8%
Discount for Device Penalty (% of 1755 MHz Cash Flow)	[N]	2.2%
Cash Flow Including Network Infrastructure Penalty (% of revenue)	[O]	22.3%
Cash Flow Including Network Infrastructure Penalty (% of 1755 MHz Cash Flow)	[P]	89.2%
Discount for Network Infrastructure Penalty (% of 1755 MHz Cash Flow)	[Q]	10.8%
Cash Flow Including Device & Network Infrastructure Penalty (% of revenue)	[R]	21.8%
Cash Flow Including Device & Network Infrastructure Penalty (% of 1755 MHz Cash Flow)	[S]	87.0%
Discount for Device & Network Infrastructure Penalty (% of 1755 MHz Cash Flow)	[T]	13.0%

[A]-[D]: Cash flow assumptions based on observations from public income statements of three wireless carriers' (i.e., Verizon Cellco, Sprint Wireless, U.S. Cellular) for 2007 through 2009, and fall within the range of minimum and maximum percentages for each line item.

[E]: 1-[A]-[B]-[C]-[D].
[F]: Brattle assumptions based on conversations with industry engineers and officials.
[G]: Brattle assumptions based on conversations with industry engineers and officials.
[H]: [A] x (1+[F]).
[I]: [B] x (1+[F]).
[J]: [C] x (1+[G]).
[K]: [D].
[L]: 1-[A]-[B]-[D]-[J].
[M]: [L]/[E].
[N]: 1-[M].
[O]: 1-[C]-[D]-[H]-[I].
[P]: [O]/[E].
[Q]: 1-[P].
[R]: 1-[H]-[I]-[J]-[K].
[S]: [R]/[E].
[T]: 1-[S].

In addition to the change in the expected costs of equipment, the un-harmonized 1690 MHz – 1710 MHz band implies additional risks that do not exist for the 1755 MHz – 1780 MHz band. Certainly, every enterprise incurs some risk of doing business. Some portion of this risk is inherent to the entire economy, while the rest is unique to the industry. Industry specific risks often include general economic risk and market failures, technological uncertainties related to research and development, and the possibility of accidents. These general market and industry specific risks and uncertainties are reflected in the industry cost of capital, defined as the weighted average return from debt and equity by firms in the industry. The cost of capital, therefore, reflects the industry specific business cycles. For telecom services, this cost of capital is estimated to be 7.4%.[54]

In addition to telecom service risks, the 1690 MHz – 1710 MHz band bears risks associated with equipment, particularly non-standard devices. For instance, it is not clear how long technological development will take, or whether the devices will have features comparable to standard counterparts. It may be that only higher end devices are developed initially. Whether equipment manufacturers find the required R&D worth undertaking, and on what time table, is susceptible to industry risk. Given the limited demand for non-standard devices, the extent to which manufacturers devote resources to their development and production is dependent on other market factors, including excess engineering capacity and demand for other goods.

One very important point about this increased risk and uncertainty about additional costs is that higher than expected costs or longer than expected delays are more likely in times of high demand for mobile services. That is, in boom times resources are less likely to be devoted to the development of devices for non-standard bands. This is more costly because the losses (when times are good) are likely to be larger than the gains (in bad times when costs are not higher or delays are shorter.)

To control for these additional uncertainties related to the telecom equipment, I apply the cost of capital for the telecom equipment industry to the valuation of the 1690 MHz pairing.[55] The cost of capital for telecom equipment is 8.2%[56], a little more than three quarters of a percentage point higher than for telecom services. This difference is suggestive of the additional risk from increased equipment uncertainty. If the increased risk was higher or lower than this amount, the impact on spectrum value would similarly be higher or lower.

To estimate the impact of a higher cost of capital on the net present value of profits, I model more specific cash flows. In order to calculate relative NPV for the 1755 MHz pairing, we assume that revenue ramps up over five years such that cash flow is positive in year five. Based on a constant five percent revenue growth from the fifth year on, the cumulative NPV is positive beginning seven years after the initial investment.[57] Assuming that the 1690 MHz band had the same general cost structure as the 1755 MHz band, the effect on the net present value from the higher discount rate on the AWS-3 pairing with the 1690 MHz – 1710 MHz band is 72% of the NPV from pairing with the 1755 MHz – 1780 MHz band. See Table 4. Assuming the value of the 1755 MHz band is almost $12 billion, this translates into a reduction in value of $3 billion.

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[54] Downloaded on April 7, 2011 from <http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm>.

[55] For additional resources on the added cost of non-standard devices for the 1690 MHz band, see, Varrall, Geoff. "RF Cost Economics for Handsets." *RTT* white paper, May 2007 <www.rttonline.com/research/RFCostEconomicsForHandsets-study.pdf>; "In the Matter of Office of Engineering and Technology Requests Information on Use of 1675 – 1710 MHz Band." *Comments of CTIA – The Wireless Association* before the FCC, ET Docket No. 10-123, June 28, 2010; "In the Matter of Relocation of Federal Systems." *Comments of 3G Americas* before the NTIA, Docket No 0906231085-91085-01.

[56] Downloaded on April 7, 2011 from <http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm>.

The decreased value from the higher expected equipment cost is done in two steps. First, the higher equipment costs associated with the 1690 MHz pair delays the cumulative NPV break-even point by one year. In the context of higher costs and risk, cash flow is still positive in year five but the cumulative NPV does not turn positive until year eight.[58] This one year penalty decreases the NPV of the 1960 MHz pairing to 70% of the 1755 MHz band pairing. Finally, adding the higher expected equipment costs to the network infrastructure costs, the NPV of the 1690 MHz band pairing is 61% of the NPV of the 1755 MHz pairing or a reduction of $4.7 billion.

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[57] Specifically, we assume that depreciation begins in year 1 at 12% of anticipated revenue at maturity. Actual revenue begins to ramp up in year 2, beginning with 12.5% of cash flow at maturity and doubling annually until it reaches maturity in year 5. Once revenue has reached maturity in year 5 it increases at 5% per year in perpetuity. Cost of service is 15% of revenue at maturity beginning in year 2. Equipment costs and SGA costs both ramp up with revenues, to 18% and 30% of revenues respectively in year 5.

[58] Assuming depreciation begins in year 1 at 12% of steady state revenue, cost of service begins in year 2 at 15% of steady state revenue, and other operating costs ramp up with actual revenues similar to the 1755 MHz band (see Table 3). Consistent with our earlier assumptions, by year 5, cost of equipment is 15% of revenues and SGA costs are 30% of revenues.

Table 4
AWS-3 Band Value
NPV for 1690 MHz Pairing Versus 1755 MHz Pairing

		Factor
Annual Growth in Cash Flow	[A]	5.0%
Cost of Capital, Telecom Services	[B]	7.4%
Cost of Capital, Telecom Equipment	[C]	8.2%
1755 - 1780 MHz NPV (as a Multiple of Annual Cash Flow)	[D]	38.4
1690 - 1710 MHz NPV (as a Multiple of Annual Cash Flow)		
Assuming Higher Equipment Cost of Capital, breaking-even in year 7	[E]	27.6
Assuming Higher Equipment Cost of Capital, breaking-even in year 8	[F]	26.8
Including Device & Network InfrastructureCost Discounts, assuming Equip. Cost of Cap, breaking even in year 8	[G]	23.3
NPV for 1690 - 1710 MHz Band as Percent of 1755 - 1780 MHz Band		
Assuming Higher Equipment Cost of Capital, breaking-even in year 7	[H]	72%
Assuming Higher Equipment Cost of Capital, breaking-even in year 8	[I]	70%
Including Device & Network Infrastructure Cost Discounts, assuming Equip. Cost of Cap, breaking even in year 8	[J]	61%

Source and Notes:
[A]: Brattle assumption.
[B], [C]: Downloaded from http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm on 4/7/2010.
[D]-[G]: Brattle calculations.
[H]: [E]/[D].
[I]: [F]/[D].
[J]: [G]/[D].

ASYMMETRIC PAIRING

The NTIA has proposed freeing 15 MHz from government use in the 1695 MHz to 1710 MHz band. This 15 MHz could be paired with the 20 MHz of the AWS-3 band. If this asymmetric pairing occurs, it would be the first time such an allocation was created in a significant band intended for mobile broadband. Clearly, other things equal, the value of pairing the AWS-3 band with 15 MHz of spectrum is less than pairing it with 20 MHz of spectrum. Because we have no direct experience with such an allocation, we cannot predict with precision what an appropriate discount would be. Nevertheless, a close approximation of the value can be found by looking at a pair of transactions that replicate the asymmetric pairing proposed: the value of 15 MHz of paired spectrum, plus the value of 5 MHz of unpaired spectrum.

The recent AT&T acquisition of unpaired 700 MHz licenses from Qualcomm is one likely comparison for adding asymmetric capacity. The analysis calculated above estimated that the $/MHz-pop value of unpaired spectrum was 60% of the value of paired spectrum. The proposed asymmetric pair would limit the spectrum to 35 MHz and reduce the MHz-pops of the allocation by 12.5%.[59] The unpaired 5 MHz of spectrum in the allocation represents another 12.5% of the MHz-pops that are valued at 60% of the optimally paired allocation. This implies that the value of the asymmetric pairing including the band penalties and additional uncertainty is 53% of the symmetric pairing with the 1755 MHz – 1775 MHz band.[60] Consequently, the additional cost of the asymmetric 1690 MHz band pairing is just less than 8%, or $1.0 billion.

CONCLUSION

As demand for mobile broadband services increases, efficient allocation of spectrum for wireless uses is essential. Ensuring that the AWS-3 band is paired to create the most capacity and highest spectrum value possible is central to this goal. To this end, this paper compares the value of pairing the AWS-3 with the 1755 MHz band to the value of pairing it with the 1690 MHz band, pairing it with the 15 MHz of the 1695 MHz band, or leaving the AWS-3 band unpaired. See Table 5. Drawing on the results of the value of the FCC AWS-1 auction, this paper estimates that the value of the AWS-3 band symmetrically paired with the 1755 MHz band is approximately $12 billion, assuming a well designed auction. Based on the additional costs of deploying the 1690 MHz band, including higher device costs, additional capital expenditures, and increased uncertainty are likely to decrease the spectrum value for the paired 40 MHz by 39% to $7.3 billion. An asymmetric pairing, combined with the equipment and infrastructure penalties and uncertainty, will result in a total of 35 MHz reducing the spectrum value by 47% to $6.4 billion. Proposed exclusion zones associated with the 1695 MHz band would reduce the value by another $1.1 billion to $5.3 billion or just 44% of the value of the 1755 MHz pairing. This amounts to a total loss of $6.7 billion from the optimally paired spectrum. While the added costs of the 1690 MHz band pairing leads to substantial loss in value, either pairing is preferred to leaving the AWS-3 unpaired. An unpaired AWS-3 is likely to receive $3.6 billion in auction receipts.

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[59] (40 MHz – 35 MHz)/40 MHz.

[60] This cumulative discount represents the weighted average discount of: (1) 30 MHz (75% of MHz-pops) of paired 1695 MHz – 1710 MHz spectrum at a 39% discount; (2) 5 MHz (12.5% of MHz-pops) of unpaired spectrum at a 40% discount; and (3) 5 MHz (12.5% of MHz-pops) of lost spectrum. Mathematically, the expression is (30 MHz * 61% + 5 MHz * 60% + 5 MHz * 0%)/40 MHz.

Table 5
AWS-3 Band Value
Estimated Value of the 1755 MHz Pair, 1690 MHz Pair and Unpaired

		Cumulative Discount *[1]*	Estimated Value *[2]*
1755 MHz Paired (40 MHz) Value	[A]		$11,981,112,224
Unpaired (20 MHz) Value	[B]		$3,619,835,261
Discounted 1690 MHz Paired (40 MHz) Value			
Including Device and Network Infrastructure Penalties	[C]	13%	$10,428,360,080
Including Device and Network Infrastructure Penalties and Added Equipment Uncertainty	[D]	39%	$7,279,982,126
Asymmetrically Paired and Discounted 1690 MHz (35 MHz) Value			
Asymmetric Spectrum (5 MHz)	[E]		$904,958,815
Including Device and Network Infrastructure Penalties (30 MHz)	[F]		$7,821,270,060
Total (35 MHz) Value With Penalties	[G]	27%	$8,726,228,875
Including Device and Network Infrastructure Penalties and Added Equipment Uncertainty (30MHz)	[H]		$5,459,986,594
Total (35 MHz) Value With Penalties and Uncertainty	[I]	47%	$6,364,945,410
Penalty Based on Excluded Population	[J]		17%
Total (35 MHz) Value With Penalties, Uncertainty, and Excluded Population Penalty	[K]	56%	$5,286,250,066

Source and Notes:

[A], [B], [C][1], [D][1]: Brattle analysis above in Tables 2 - 4.
[C][2]: [A][2]*(1-[C][1]).
[D][2]: [A][2]*(1-[D][1]).
[E][2]: [A][2]*(1-0.4)*(5/40).
[F][2]: [C][2]*(30/40).
[G][1]: (1-[G][2]/[A][2]).
[G][2]: [E][2]+[F][2].
[H][2]: [D][2]*(30/40).
[I][1]: (1-[I][2]/[A][2]).
[I][2]: [E][2]+[H][2].
[J]: Table 1.
[K]: (1-[J])*[I].